THE physical therapy REVIEW

38th Annual Conference
American Physical Therapy Association
The Palmer House Chicago, Illinois
July 2-7, 1961

40th ANNIVERSARY

Muscle Testing: Part 1. Description of a Numerical Index for Clinical Research — SMITH, IDDINGS and SPENCER

The Influence of Athetoid Cerebral Palsy on The Execution of Sport Skills: Bowling. A Study of One Case — HELLEBRANDT, WATERLAND and WALTERS

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Volume 41, Number 2 **February 1961**

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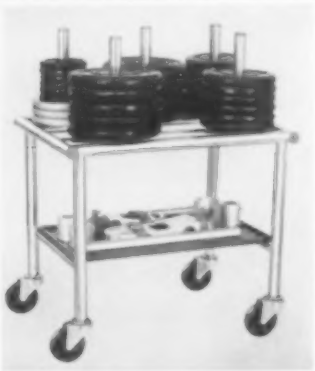

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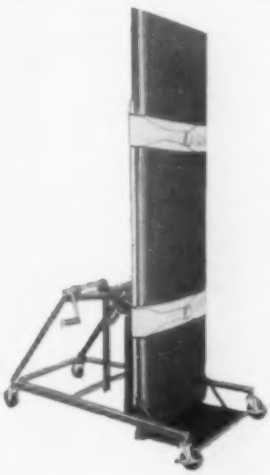

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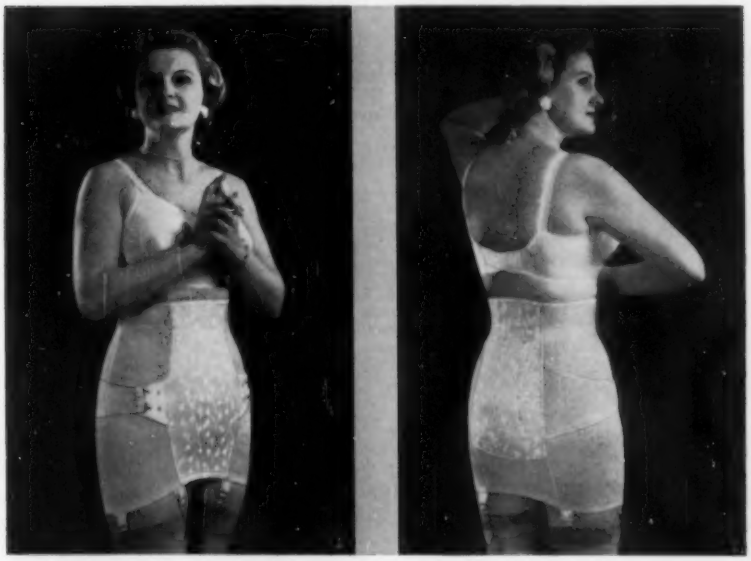

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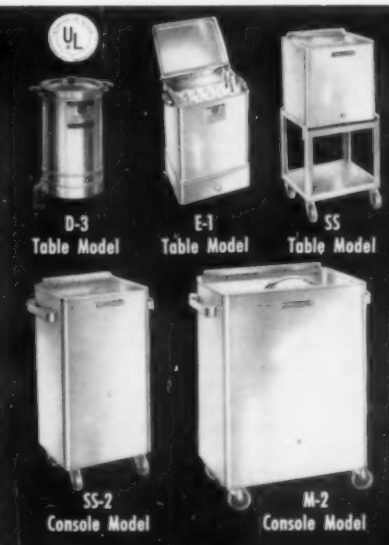

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Indiana: Annual examination. Mid-June. File applications by May 15. Apply to Ruth V. Kirk, Exec. Sec., State Board of Medical Registration and Examination, 538 K. of P. Building, Indianapolis 4. Examinations held at Indiana University Medical School, 1100 W. Michigan, Indianapolis.

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Maine: Thrice yearly examinations. Apply to Stephen A. Cobb, M.D., Sec. Medical Examining Board, 34 Winter St., Sanford. March and November examinations held at Portland City Hall, Portland; July examination held at State House, Representative Chambers, Augusta.

Maryland*†: Apply to State Board of Physical Therapy Examiners, 301 W. Preston St., Baltimore 1.

Massachusetts†: Semiannual examinations, April and October. File application two weeks in advance. Apply to Board of Registration in Medicine, State House, Boston 33. Examinations held at State House, Boston.

Minnesota*: Apply to State Board of Medical Examiners, 230 Lowry Medical Arts Building, St. Paul 2.

Nebraska*: Apply to R. K. Kirkman, Dir., Bureau of Examining Boards, Room 1009, State Capitol Building, Lincoln.

Nevada*†: Semiannual examinations. Apply to Margaret Heidrich, 506 Humboldt St., Reno. Examinations held in Reno or Las Vegas.

New Hampshire*†: Apply to Edward W. Colby, M.D., Sec., Board of Registration in Medicine, 61 So. Spring St., Concord. Examinations held at State Health Building, 61 So. Spring St., Concord.

New Mexico*: Apply to Registrar, Physical Therapists Licensing Board, Box 2206, Santa Fe.

New York: Semiannual examinations; June and December. File applications at least 30 days in advance. Graduates of registered curriculum apply to John W. Paige, Chief, Bureau of Professional Examinations and Registrations, 23 South Pearl St., Albany 7; graduates of nonregistered curriculum apply to Robert C. Killough, Jr., Assistant Commissioner for Professional Education, 23 So. Pearl St., Albany 7. Examinations are held in Syracuse and New York City.

North Carolina*†: Semiannual examinations. Apply to Edith M. Vail, Sec., Dept. of Physical Therapy, N. C. Baptist Hospital, Winston-Salem.

North Dakota*†: Apply to Harriet Deery, Sec., State Examining Committee for Physical Therapists, Crippled Children's School, Jamestown. Examinations held in January and July. File applications one month in advance.

Ohio: Apply to: Herbert M. Platter, M.D., Exec. Sec., Ohio State Board of Medical Examiners, 21 W. Broad St., Columbus.

Oklahoma*: Apply to Lucy Haidek, Exec. Sec., Board of Medical Examiners, Braniff Building, Oklahoma City. Examinations held at Board of Medical Examiners, Braniff Building, Oklahoma City.

Oregon†: Apply to Oregon State Board of Health, 1400 S. W. 5th Ave., State Office Bldg., Rm. 866, Portland 7.

Pennsylvania†: Semiannual examinations, January and July. File application December 15 or June 1. Apply Mrs. Alva R. Cockley, Sec. State Board of Medical Education and Licensure, Box 911, Harrisburg. January examination held in Philadelphia; July examinations held in Philadelphia and Pittsburgh.

South Carolina*†: Apply to Dorothy B. Allen, Physical Therapy Dept., Columbia Hospital, Columbia 14.

South Dakota*†: Apply to John C. Foster, Exec. Sec., State Board of Medical and Osteopathic Examiners, 300 First National Bank Bldg., Sioux Falls.

Tennessee†: Annual examination, second Monday in June. File application one month in advance. Apply to Board of Medical Examiners, 1633 Exchange Bldg., Memphis. Examinations held in Nashville.

Utah†: Annual examination first Tuesday in May. File application two weeks in advance. Apply to Frank E. Lees, Director, State Department of Registration, Room 318A, State Capitol Building, Salt Lake City.

Vermont*†: Apply to Sophie Myers, Sec., Board of Physical Therapy Registration, De Goesbriand Memorial Hospital, Burlington.

Virginia†: Semiannual examinations, February and September. Apply to Russell M. Cox, M.D., Sec., State Board Medical Examiners, 509 Professional Bldg., Portsmouth. Examinations held in Richmond.

Washington†: Annual examination, May. File applications by April 1. Apply to Professional Division, Department of Licenses, Olympia. Examinations held in Seattle.

Wisconsin*: Thrice yearly examinations, April, Mid-September and at the discretion of Examining Committee. File applications at least two weeks in advance. Apply to Emma Zitzer, Sec., Physical Therapy Examining Committee, 207 North Brooks St., Madison 5. April examination held in Milwaukee; September examination held in Madison.

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* Information regarding examination dates and/or place of examination will be provided upon receipt of application.

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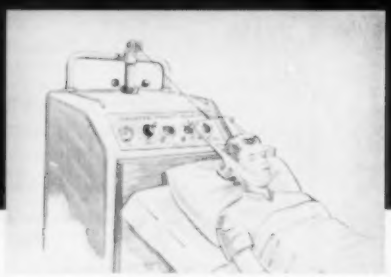

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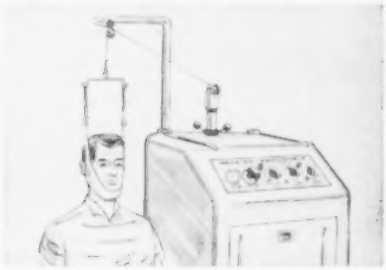

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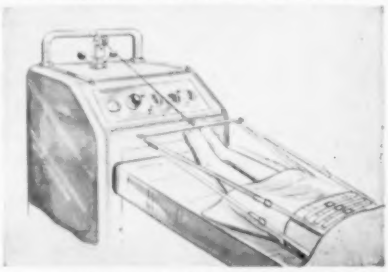

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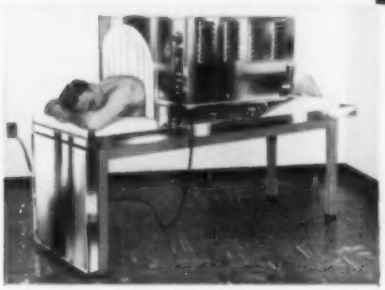

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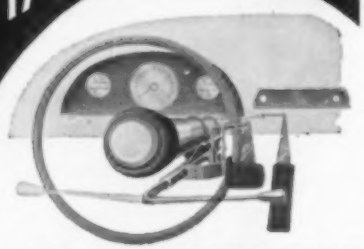

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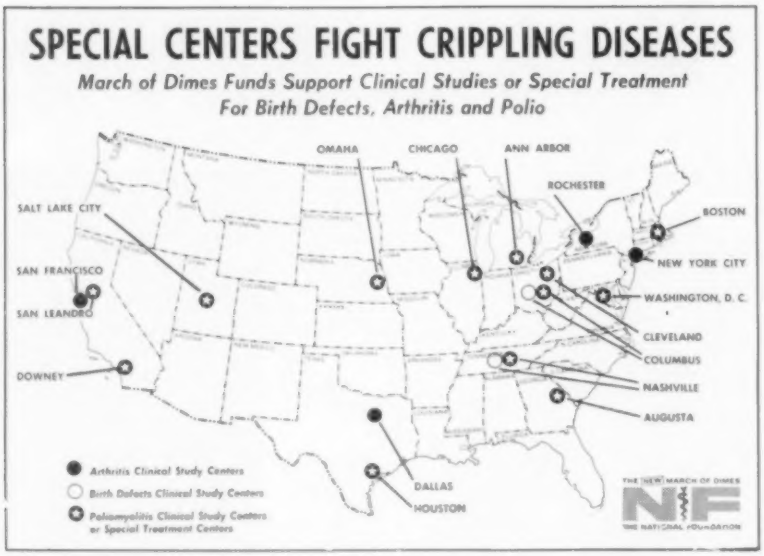

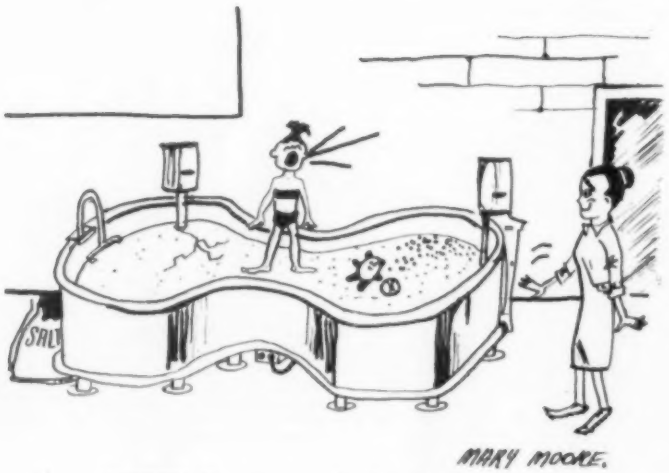

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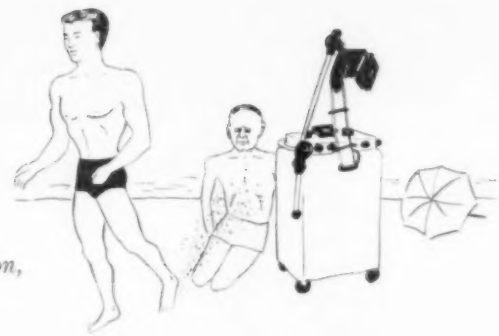

(Then I founded The Birtcher Corporation, and lost 4 more pounds)

As I sit writing this, we've just finished a little dinner at a restaurant around the corner from the plant. It was quite a meal . . . and the occasion was a "get-together" with those people here at the factory that helped me get this outfit going in 1936, just 25 years ago.

Al Babeaux was across from me. He's a pretty unsung guy in the industry, being in the Production and Engineering end. I sure remember a lot of nights over the years when Al's light was burning long after everybody else had gone home . . . as he sat and tried to figure what was wrong with a drawing, or how a design could be improved, or how we could possibly manufacture enough units to fill a big order I might have sent in from the east. He's the senior vice-president now, but I somehow will always remember him as a big gangling kid engineer who wanted to make our units the best in the world.

Next to Al, and eating a big steak, was Sacha Bollas. Sacha is our Export Division chief, and a good one. Back in '36, though, we didn't know if we could sell outside of California . . . and when Sacha came in with an idea for exporting the units, we had to think about it quite a while. He's really done a job for us—we're currently shipping to 88 foreign countries this month—but I still couldn't help but think how scared we were back then when he mentioned "Europe."

On either side of me at the table were Ed Townsend and Bill Cobleigh. Bill was the machinist back in '36, and Eddy was our assembler. They're celebrating a quarter century with us, too. Bill's a research-and-development engineer now, and Eddy's a senior machinist.

It wasn't a very big dinner . . . there were only five of us. But that's all there were back in '36, too. The only people missing were a lot of M.D.'s and Physical Therapists out there that have been with us all these years, too. I wish you could have all been here . . . you've been as much a part of our growth as any one of us.

It's been a long road, but a good one. I hope you'll forgive me for being such a sentimental idiot today . . . it's just that a Silver Anniversary doesn't come around very often.

Cordially,

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Cecil Birtcher, President
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The Physical Therapy Review

Official Publication of The American Physical Therapy Association

Muscle Testing: Part 1. Description of a Numerical Index for Clinical Research

Laura K. Smith, A.B., Dorothy M. Iddings, A.B.,
William A. Spencer, M.D. and Paul R. Harrington, M.D.

Physical therapists have been called upon for many years to evaluate neuromuscular and functional disabilities. The method of grading manual muscle tests, first endorsed by the National Foundation for Infantile Paralysis, Inc., in 1946,[1] has been generally accepted as standard. These tests are meaningful and useful to the physician and physical therapist in planning, executing, and evaluating restorative treatment for patients with final common pathway lesions. However, in many aspects of clinical research the manual muscle test is found to be impractical, especially when it is desired to study large numbers of patients.

The manual muscle test was used as a tool for research in the field trial studies which were carried out to determine whether gamma globulin and the Salk vaccine would protect against paralysis in poliomyelitis.[2, 3, 4] The index of total involvement for each patient based on the muscle evaluation was one of the variables used to study the effectiveness of the immunization.

Briefly, 124 muscles or muscle groups (82 in the revised test) were graded on a scale of 0 to 5 points: Normal—0; Good—1; Fair—2; Poor—3; Trace—4; Zero—5. Each of the muscles or groups was assigned a factor from .25 to 4 based on its bulk. Multiplication of the grade value by the muscle factor produced the score for the muscle. The addition of the individual scores gave the total test value with 0 indicating no involvement, and 560 (470 in the revised test) indicating total involvement. The division of the total score by the total possible, i.e., 560, gave percentage of involvement.

This method has shown its value in a research situation, but its routine clinical use is limited. This paper describes a dimension that has been added to the manual muscle test in order to meet the needs of detailed investigations within the framework of daily clinical treatment duties. Clinical research requires that the muscle test be detailed for treatment purposes but convertible to a useful figure without excessive demands on the physical therapist's time. The method should utilize concepts that have been accepted. For example, the concept that the grade Normal, 5, and 100 per cent, have the same meaning should be retained. Very importantly, the mathematics must be kept in the most elementary and obvious form so that the test score can be easily computed and quickly understood by the many persons concerned with its use. These range from clerks doing the recording and calculation to the biochemist who may wish to use such data to refine the description of a research population.

From the Department of Rehabilitation, Baylor University College of Medicine, the Texas Institute for Rehabilitation and Research, and the Poliomyelitis Study Center of the Institute. The Study Center is supported by grants-in-aid from the National Foundation.

DESCRIPTION

Figures 1 and 2 show the muscle test form developed by Paul R. Harrington, M.D.,* in 1950. It was put into daily clinical use at the Southwestern Poliomyelitis Respiratory Center in 1953, and retained in use at the Texas Institute for Rehabilitation and Research. In general, this test form is similar to many muscle test forms in use elsewhere. Specifically, 154 muscles (including some groups of muscles) are listed and the muscles of the fingers are divided into four digits. The muscles concerned with facial expression, mastication, and swallowing are not included. Double columns are provided for three serial tests. The wider part of the column is used by the physical therapist for assigning letter grades, and the narrower part is used in figuring the numerical estimate of total involvement.

Muscles are assigned letter grades according to the standards of the Committee on After-Effects, National Foundation for Infantile Paralysis, Inc.[1] Plus and minus values are utilized for finer gradation. Limitation of range of motion for a specific test is indicated by a parenthesis, i.e., (G). Inability to test accurately, due to lack of cooperation or inability to properly position the patient, is indicated by a question mark, i.e., (G?). Complicating factors such as congenital defects, pregnancy, hypertonicity, surgery and others, are noted by an asterisk. The muscles of respiration are graded by fluoroscopy by physicians using the following criteria:

Diaphragm:

Normal:	Movement of 1½ or more intercostal spaces (on maximum inspiration)
Good:	Movement of 1 to 1½ intercostal spaces
Fair:	Movement of ½ to 1 intercostal space
Poor:	Movement of ¼ to ½ intercostal space
Trace:	Flicker of motion
Zero:	No motion

Intercostals:

Normal:	Posterior rib elements move to a horizontal level on inspiration
Good:	Posterior rib elements will move but not to horizontal level
Fair:	Some elevation of posterior rib elements
Poor:	Slight elevation of posterior rib elements
Trace:	Flicker of motion
Zero:	No motion

This is a subjective estimation of movement in a fluoroscopic image and undoubtedly it is only grossly accurate; however, it is more accurate than observations made without the aid of the fluoroscope.

The statistical portion of the test assigns representative numerical values to letter grades: N–5, G–4, F–3, P–2, T–1, O–0. In addition, factors of 1, 2, 4 or 6 have been assigned to each muscle or muscle group (Fig. 1 and 2) so that a numerical value can be given by multiplying the grade value by the factor. These factors were formulated by the following procedures: a figure of 1,000 points was assigned arbitrarily as normal muscle test-strength for the sum of all muscles listed on the muscle test form. For the purposes of showing general areas of involvement, three primary divisions of the body were designated and given approximately equal values: the trunk—320 points, the upper extremities—340 points, and the lower extremities—340 points. These were subdivided into right and left sides.

The individual muscle or group was then assigned the factor of 1, 2, 4, or 6 within each primary division. Selection of a factor was based on the relative bulk and on the necessity of fitting the individual numbers into the primary, arbitrary division total.† Multiplication of the muscle factor by the representative numerical grade value gives the individual muscle score. The following chart illustrates the derived scores:

Muscle Test Grade	Numerical Value	Muscle Factor 1	2	4	6	
N	5	5	10	20	30	
G	4	4	8	16	24	
F	3	3	6	12	18	Derived
P	2	2	4	8	12	Muscle
T	1	1	2	4	6	Score
O	0	0	0	0	0	

(Appropriate variations in scores are made for plus or minus grades of muscles with factors of 2, 4, or 6.)

Scores are then totaled for each segment and placed in the box in the lower right hand corner of the muscle test form. The addition of these numbers gives the total score for the test. By moving the decimal point one place to the left, a percentage of functioning skeletal musculature, based on the manual muscle test, is readily derived.

Only muscles that can be reasonably tested and graded by manual muscle-testing procedures or fluoroscopy are included in the statistical part of the test. The pectoralis minor, brachialis, and

* Orthopedic Consultant, Texas Institute for Rehabilitation and Research, and Clinical Associate Professor, Departments of Surgery and Rehabilitation, Baylor University College of Medicine, Houston, Texas.

† Numbers 3 and 5 did not seem to work out adequately and therefore were not utilized.

LEFT NECK, TRUNK, AND LOWER EXTREMITIES RIGHT

	10-1-59 DI		12-12-55 DI		8-22-55 DI		Factor	Date / Examiner's Initials	Factor	8-22-55 DI		12-12-55 DI		10-1-59 DI		
NECK	10	N	7	F+	5	(P+)?	2	Sterno-Cleido-Mastoid	2	(P+)?	5	F+	7	N	10	NECK
	10	↓	7	F+	5	↓	2	Accessory Neck Flexors	2	↓	5	F+	7		10	
	10		10	N	6	F?	2	Cervical Erector Spinae	2	F?	6	N	10		10	
TRUNK	10		10	N	8	G	2	Diaphragm	2	P	4	N	10		10	TRUNK
	10		10	N	8	G	2	Intercostals	2	G	8	N	10		10	
	10		8	G	6	(F)?	2	Upper Rectus Abdominis	2	(F)?	6	G	8		10	
	10		8		6		2	Lower Rectus Abdominis	2		6		8		10	
	10		8	↓	6	↓	2	External Oblique	2	↓	6	↓	8		10	
	10		8	↓	6	↓	2	Internal Oblique	2	↓	6	↓	8		10	
	30		30	N	18	F?	6	Thoracic Erector Spinae	6	F?	18	N	30		30	
	30		30	N	18	↓	6	Lumbar Erector Spinae	6	↓	18	N	30		30	
	10	↓	5	P+	6	↓	2	Quadratus Lumborum	2	↓	6	P+	5	↓	10	
	160		141		98			160 Total 160			94		141		160	
HIP	10	N	8	G	8	G?	2	Gluteus Maximus	2	O?		P-	3	G+	9	HIP
	5	↓	4	G	4	G	1	Outward Rotators	1	↓		O		P-	2	
	5	↓	4	G?	4	G	1	Inward Rotators	1	↓		O		P-	2	
	4	G+	4	G	2	P+	1	Gluteus Medius	1	↓		P-	2	P+	2	
	8	G	6	F?	8	G	2	Iliopsoas	2	↓		O		P+	5	
	9	P+	9	P+	9	P+	4	Adductors	4	↓		O		O		
	4	G+	4	G	2	P+	1	Tensor Fascia Latae	1	↓		P-	2	P+	2	
	4	G	3	F?	4	G	1	Sartorius	1	↓		O		P+	2	
KNEE	9	P+		O		O	4	Quadriceps Femoris	4	↓		↓		O		KNEE
	10	N	8	G	8	G	2	Biceps Femoris	2	↓		↓		↓		
	5	↓	4	↓	4	↓	1	Semitendinosis	1	↓		↓		↓		
	5	↓	4	↓	4	↓	1	Semimembranosus	1	↓		↓		↓		
ANKLE	5		2	P+ ST.	3	F+Y	1	Gastrocnemius	1	↓		↓		↓		ANKLE
	5		2	P+ ST.	3	↓	1	Soleus	1	↓		↓		↓		
	5		4	G	2	P+	1	Anterior Tibial	1	↓		↓		↓		
	5		4		4	G	1	Posterior Tibial	1	↓		↓		↓		
	5		4		4		1	Peroneus Longus	1	↓		↓		↓		
	5		4		4		1	Peroneus Brevis	1	↓		↓		↓		
TOES	5		4		4		1	Extensor Hallucis Longus	1	↓		↓		P+	2	TOES
	5		4		4		1	Flexor Hallucis Longus	1	↓		↓		O		
	5		4		4		1	Flexor Hallucis Brevis	1	↓		↓		O		
	5		4		4		1	Extensor Digitorum Longus	1	↓		↓		P-	2	
	5		4		4		1	Lumbricales	1	↓		↓		O		
	5		4		4		1	Flexor Digitorum Brevis	1	↓		↓		O		
	5	↓	4	↓	4	↓	1	Flexor Digitorum Longus	1	↓		↓		O		
	143		106		105			170 Total 170			0		7		28	

KEY:*

N	Normal	Complete range of motion against gravity with full resistance.
G	Good	Complete range of motion against gravity with *moderate* resistance.
F	Fair	Complete range of motion against gravity.
P	Poor	Complete range of motion with gravity *eliminated*.
T	Trace	Slight contraction without joint motion.
O	Zero	No evidence of contraction.

Date	8-22-55		12-12-55		10-1-59	
	L	R	L	R	L	R
Trunk (160-160)	98	94	141	141	160	160
Lower Extremity (170-170)	105	0	106	7	143	28
Upper Extremity (170-170)	170	170	170	170	170	170
Total (1000)	637		735		831	

* ( ) = Tightness of the antagonist limits range of motion. i.e. (G)
? = Unable to test accurately due to lack of cooperation or inability to position properly for test. i.e. G?

FIG. 1. Manual muscle test form used at the Texas Institute for Rehabilitation and Research. Three muscle tests of a poliomyelitis patient are recorded 10 days, 4 months, and 51 months from onset. Numeric values are also represented. This procedure is necessary for manual derivation of the total muscle score. Use of electronic data processing has eliminated the need for numeric values to appear on the muscle test form and only the total score is placed in the lower right hand boxes.

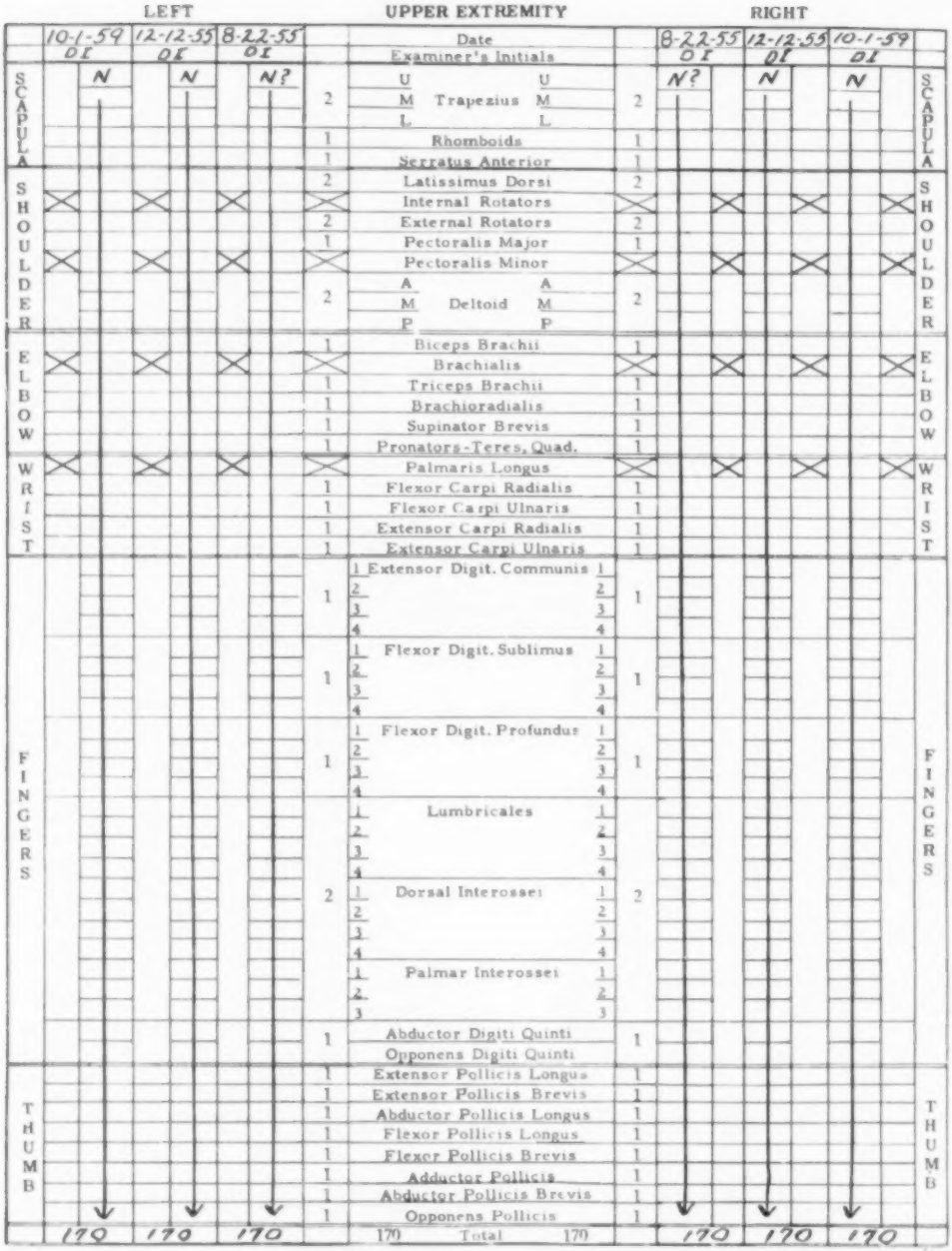

FIG. 2. The reverse side of the manual muscle test form. Arrows indicate a repeat of the grade above.

palmaris longus are not included in the statistical portion due to frequent difficulty in grading. The internal rotators of the shoulder are deleted from the statistics because of duplication.

The forms and recording methods in use have been suitable for direct conversion to electronic data processing (EDP). The muscle test as written originally by the physical therapist is sent directly to the EDP department where the test is put on data cards; simple calculations are done by machine, and both letter grades and statistical results are listed for the medical chart. The storage of data on cards permits extensive statistical analysis or selection of patients without increased use of professional personnel time.

DISCUSSION

All forms of measurement are derived from an arbitrary standard or definition. Incorrect assumptions and conclusions from statistical distortions can be readily introduced, unless there is an understanding of the definition (i.e., muscle test), the derived quantity (muscle number) and, therefore, what the derived quantity can measure.

The manual muscle test itself does not contain precisely comparable quantities, nor is it able to differentiate the wide range of "normal" strength.

The arbitrary definitions for grading of performance were developed and accepted for purposes of standardization. A linear functional relationship between the muscle grades has often been assumed, but was not incorporated in the original definitions. Many authors [1, 5, 6, 7, 8] point out that grade steps in the same muscles do not represent equal differences in muscle work, expressed as tension during contraction or as a linear decrement in strength, as a result of disease processes. It is also pointed out that the same grade in different muscles may represent different degrees of force.[1] Thus, the assignment of arbitrary numbers to an already arbitrary and subjective test cannot lead to a more precise scientific measurement. Yet, it does offer a dimension for practical use of the manual muscle test in clinical descriptive research as a general index to severity of neuromuscular involvement, and as to the pattern or rate of change in strength in the same individual (Fig. 3).

The limitations and merits of the muscle number must be recognized in order to use it effectively. The muscle number does not replace the ordinary use of the muscle test. The muscle number does not show functional ability, except

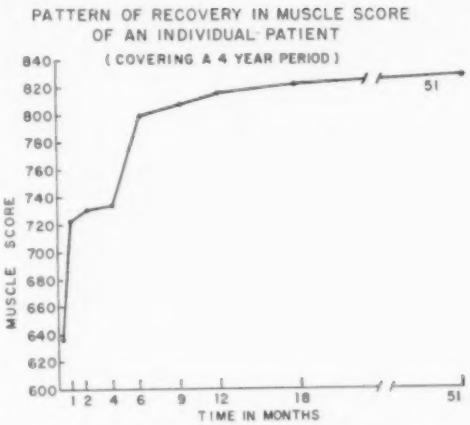

FIG. 3. Total muscle scores of a poliomyelitis patient recorded at various intervals, the first test performed 10 days from onset of disease and the last performed 51 months from onset. Three of this patient's muscle tests are recorded in Figures 1 and 2.

grossly at the extremes. A specific number, such as 850, does not indicate whether the loss is due to general asthenia, paresis or paralysis. For this reason, in the vaccine field trials, muscles with a grade of "good" were eliminated in the computation.[2] The muscle number developed here has been used in connection with virus studies.‡ In order to grossly indicate the presence of paresis or paralysis, the total muscle score is recorded, as well as the number of muscles scored zero, i.e., 850–10.

It is possible that to some extent the muscle-test score reflects the muscle bulk, and therefore, the relationship of creatinine excretion and the muscle-strength scores has been studied. Creatinine is an end product of muscle metabolism. It is notably reduced in the absence of functioning muscle, i.e., in muscular dystrophy and poliomyelitis. Figure 4 shows the relationship of the individual muscle number in 33 adults with paralytic poliomyelitis of various degrees of severity and their 24-hour urinary creatinine excretion. Whereas both measurements are of limited discrimination there appears to be some association between the two determinations. The poorest correlation appears in the region of markedly reduced excretion. This would be expected since creatinine is also a product of smooth and cardiac muscle, as well as skeletal muscles not measured by this particular

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muscle test. Also, there are possibilities of the existence of functioning though untested muscle tissue which can account for some deviation from predicted measurements.

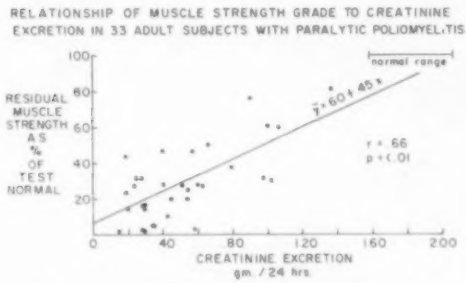

FIG. 4. Comparison of total muscle score (one year or more from onset of poliomyelitis) and the 24-hour urinary creatinine excretion.

The total muscle number does give a representation of the departure of muscle strength from the test normal. It can be used to show changes in muscle strength status (Fig. 3 and 5), but the entire muscle test warrants detailed study to determine whether changes in test score are due to an increase in the strength of muscles present or the return of previously absent ones.

Inspection of the primary division total gives further identity to the involvement of segments. Either the total or segmental scores may be utilized to select individuals for studies or to separate patients into groups for correlation with other findings.

The muscle number has been useful in case presentations to replace words such as "severely involved" or "very severely involved" with a more uniformly understood "90 per cent loss of functioning skeletal musculature." Medical personnel who are unfamiliar with definitive muscle-testing terminology find it easy and meaningful to follow and participate in the neuromuscular aspects of a patient's progress report when total or segmental scores are utilized (Fig. 3). Interest is maintained even though the discussion progresses to individual muscles and grades. In addition, the muscle number has been found useful by physicians as a convenient and readily understood method of explaining to the family the degree of involvement, neuromuscular status, and prognosis for the patient.

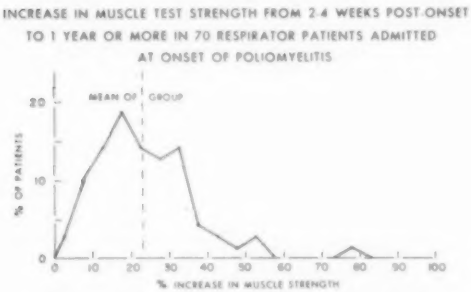

FIG. 5. Total muscle score gained by 70 poliomyelitis respiratory patients from initial muscle test (2 to 4 weeks from onset) to stabilized muscle test (one or more years from onset) shows average gain of 22% (225 points). Patients with a score of 1,000 (100%) not included in this series. Respirator patients are defined as having: (1) spinal or bulbo-spinal poliomyelitis with; (2) respiratory muscle paresis or paralysis identified by fluoroscopy or apnea and; (3) who required a tank respirator for at least 2 weeks.

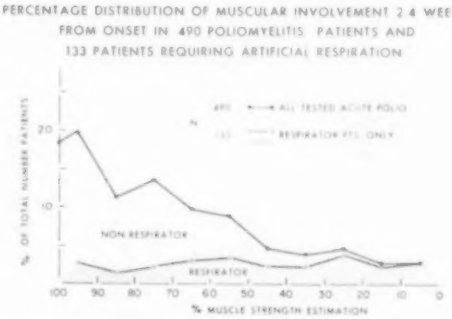

FIG. 6. Total muscle score (2 to 4 weeks from onset) of poliomyelitis patients admitted to the Southwestern Poliomyelitis Respiratory and Rehabilitation Center during their febrile illness. Respiratory patients are delineated within the group. They are defined as in the legend of Figure 5.

The muscle number can be useful for describing populations. For example, Figure 6 presents the scores of poliomyelitis patients two to four weeks from onset. The patients who had respiratory muscle paralysis or paresis and who required the tank respirator continuously for at least two weeks during their acute phase are delineated within the group. It can readily be seen that the greater the muscle loss the more likelihood of respiratory muscle involvement. It can also be seen that respirator patients are represented throughout the entire range of muscle scores recorded in this group.

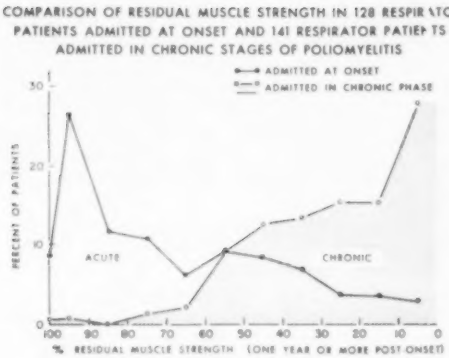
COMPARISON OF RESIDUAL MUSCLE STRENGTH IN 128 RESPIRATOR PATIENTS ADMITTED AT ONSET AND 141 RESPIRATOR PATIENTS ADMITTED IN CHRONIC STAGES OF POLIOMYELITIS
ADMITTED AT ONSET
ADMITTED IN CHRONIC PHASE
PERCENT OF PATIENTS
ACUTE
CHRONIC
% RESIDUAL MUSCLE STRENGTH (ONE YEAR OR MORE POST ONSET)

FIG. 7. Stabilized muscle score (one year or more from onset) of two groups of poliomyelitis respiratory patients. One group (acute) was admitted to the Southwestern Poliomyelitis Respiratory and Rehabilitation Center during the febrile phase of the disease (up to 2 weeks from onset). The chronic group was transferred to the Center later in their disease (one month or more after onset).

Figure 7 presents the residual muscle strength of these same respirator patients, treated from onset and followed for one year or more, compared with a population of respirator patients who were admitted one month or more from onset. The wide range of *differences* between the groups, as well as among individuals of the same group, can be seen. The chronic group includes those with the severe problems from diverse and widespread areas of our country. The patients treated from onset represent a more homogeneous disease population from the standpoints of area, time, and methods of treatment. Thus, with large groups of patients, the muscle number may be useful as one means of assisting in evaluating or comparing treatment programs or the range of severity of certain diseases.

The muscle-number curves shown in Figures 6 and 7 indicate that many psychologic, metabolic, viral, pulmonary, and cardiovascular studies would be enhanced by inclusion of the muscle status in the description and correlations of findings on poliomyelitis and respiratory poliomyelitis patients.

CONCLUSION

The detailed manual muscle test is at present the only clinically practical method for muscle strength estimation of the whole body as a measure of final, common pathway involvement. It has been used extensively in the evaluation and treatment of individual patients. The addition and use of a numerical index is not without danger. Valid use of the muscle number requires extensive judgment and appreciation of not only the few limitations mentioned, but also such factors as the type of condition, stage of that condition, cooperation of the patient, age of the patient, medical or physical complications, accuracy of the examiner, and reliability of different examiners. (A study of examiner reliability will be presented in Part II.) If the inherent measurement limitations of the muscle test are given proper consideration, it is practical to compute and use a numerical index of total involvement. This does not substitute for or detract from the ordinary uses of the muscle test, but it does make the manual muscle test more useful in areas of education and patient investigation. Thus, the physical therapists' routine muscle tests can be available for additional contributions in descriptive clinical research.

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The Influence of Athetoid Cerebral Palsy on the Execution of Sport Skills: Bowling

A Study of One Case

F. A. Hellebrandt, M.D., Joan C. Waterland, M.S., and C. Etta Walters, Ph.D.*

Even the severely disabled cerebral palsied patient can execute selected sport skills. An adult subject suffering from quadriplegic athetosis was permitted to perform a basic movement associated with four different athletic activities. The resultant behavior patterns were studied. Bowling was the first sport skill analyzed.

Throwing a bowling ball suppressed all overt manifestations of involuntary motion on the ipsilateral side. The movement cycle looked surprisingly smooth and efficient. Such athetosis as could be seen was limited to the distal parts of the contralateral appendages. It was more evident in the upper extremity than in the lower. A primary finding was the strong operation of the attitudinal reflexes.

The purpose of this case report is to present a cinematographic and electromyographic analysis of the bowling throw as executed by a cerebral palsied patient and to compare this with normal performance.

Methods

Subjects of the Investigation

Two adult females, both in the early fifth decade of life, participated in the experiment herein reported. M. A. had a moderately severe athetoid cerebral palsy of congenital origin, quadriplegic in distribution and more marked in the upper than in the lower extremities. The disability was worse in the right than in the left hand. The left upper extremity was therefore chosen for training. The subject could ambulate with Canadian crutches. There was consistently more athetosis in the left than in the right lower extremity. Balance was too precarious to permit bowling from the standing position. The act was therefore performed from a comfortable sitting posture on a sturdy stool provided with a smoothly revolving seat. The height of the stool was adjusted to allow the bowling ball to clear the floor at the lowest point in the arc of the anteroposterior swing.

The control subject was a professional physical educator with bowling experience, both as a performer and a teacher. She supervised the training of two pathological subjects, one of whom was the athetoid subject reported here. The other was a cerebral palsied patient with spastic hemiplegia upon whom observations also were made.

The Bowling Throw

The cerebral palsied patient and the normal control subject executed the act with opposite arms. Instead of holding the ball in front of the chest at the starting position and steadying it with the opposite hand, which is customary, the volitional aspect of the act was simplified for the cerebral palsied subjects by limiting motion to humeral advancement and retraction. The ball was placed on the floor approximately in the mid-coronal plane, to the right or left side of the subject, depending on the handedness. It could be grasped easily by bending forward

From the Motor Learning Research Laboratory, Medical School and School of Education, University of Wisconsin (310 Lathrop Hall), Madison, Wisconsin. Supported by the Easter Seal Research Foundation, National Society for Crippled Children and Adults, Inc., and the University Research Committee, the Graduate School, University of Wisconsin.

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slightly and leaning to the side. A bowling ball is held by the thumb and the third and fourth fingers. To throw a "straight ball" the forearm must be supinated and the wrist hyperextended. The subjects were instructed to bring the ball forward in a preparatory swing, then let it drop back, and finally, to drive it forward again in the power stroke. There were no pauses between the forward-backward-forward phases of the cycle. The ball was released shortly after the arm had swung through the perpendicular position on the "beat" or power stroke. The follow-through and recovery segments of the movement pattern also were studied.

The Training Program

Bowling not only requires the use of many muscles in appropriate sequence, but also the development of sufficient power to impart enough velocity to the ball for it to traverse the alley and disperse the pins. M. A., the cerebral palsied patient, needed training in both elements of the act: skill and strength. To expedite motor learning the throwing pattern was first practiced on the shoulder ergograph. This device restricts motion to virtually pure flexion and extension at the glenohumeral joint. To augment the strength constituent, resistance, speed, and range of motion could be increased progressively. As soon as the "idea" and "feel" of the throw had been grasped, M. A. extended her learning experience to manipulation of a bowling ball fitted to her individual left-handed grasp. A ten-pound ball was selected. This is lighter than the ball used by the average female bowler. Strength and endurance were gained by increasing systematically the number of throws per diem, assuring that the range of the preparatory forward and back swings was always the maximal attainable. Eventually, as many as one hundred throws could be made in a single practice session. These were divided into bouts of ten in which the hemiplegic and the athetoid subjects threw the ball in alternation. Competition proved to be an excellent motivational device. The subjects practiced three times a week. Approximately one month of training was required before the act had been sufficiently well learned to warrant cinematographic and electromyographic observations.

Photographing the Movement Pattern

Both M. A. and the normal control subject were photographed on the same day. To prevent fatigue, one performer and then the other threw the ball in each of four positions: *first*, in profile with the throwing arm facing the camera; *second*, in profile from the contralateral side; *third*, directly facing the camera; and *fourth*, from the rear view. Two consecutive trials were allowed in every position. Thus, each subject threw the ball eight different times. Motion pictures were made at the normal speed of sixteen frames per second. To expedite frame-by-frame analysis of the movement patterns, the cinematograms were enlarged to 3.5 inches by 5 inches and were recorded on direct positive paper in sequential strips of consecutive exposures. Each throwing cycle was then compressed into a short frieze which could be encompassed in a single glance. The series usually contained eight exposures. The first depicted the subject fitting the hand to the ball in preparation for the throw. There then followed in succession the posture assumed at the instant the ball began to move forward, the end of the forward swing, the point in the back swing when the arm is approximately perpendicular to the floor, the end of the back swing, that point in the power or "beat" stroke when the ball is released, the end of the follow-through movement of the throwing arm, and finally, recovery from the throw. Approximately equivalent points were identified in all four views. By looking at the friezes horizontally the observer could reconstruct the movement cycle as visualized in any one of the four orientation planes. The friezes could then be aligned vertically to permit examination of each key phase, as though being viewed concurrently from the front, back, right, and left sides. Patterning on repeated throws was sufficiently similar to make vertical alignment of approximately identical phases of each movement cycle a worthwhile analytical procedure.

Electromyography

Action potentials were recorded by an eight-channel ink-writing oscillograph, using bipolar surface electrodes. Various combinations of the following muscles were sampled: anterior, middle and posterior deltoid; biceps; triceps; pectoralis major; latissimus dorsi; upper, middle, and lower trapezius; teres major or minor; infraspinatus; wrist flexor; wrist extensor; and right and left sternocleidomastoids. Major observations were confined to the ipsilateral or throwing side. More limited recordings were obtained from selected muscle groups of the opposite side, especially the deltoid, biceps, triceps, and wrist muscles.

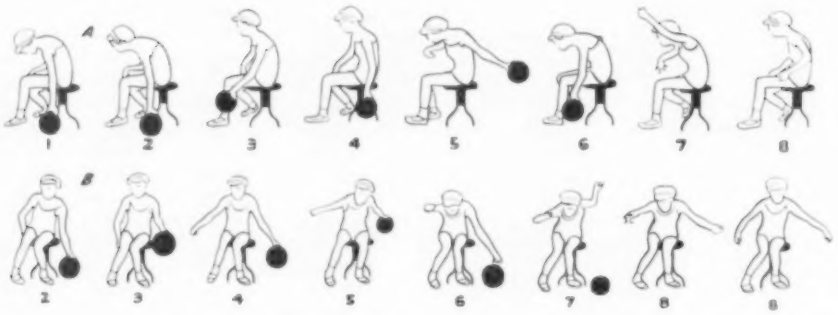

FIG. 1. Key positions in the bowling throw of an adult athetoid cerebral palsied subject: (1) preliminary placement of hand, (2) first discernible movement of the ball forward, (3) end of preparatory forward swing, (4) point in back stroke where arm is approximately perpendicular, (5) end of back swing, (6) point of release in power stroke, (7) follow-through, and (8) recovery.

RESULTS AND THEIR DISCUSSION

The photographic data consisted of eight bowling throws by each of two subjects, one pathologic and one normal, yielding 823 and 601 frames, respectively. Of these, 1093 were enlarged photographically to facilitate detailed study. The main features of the response of the athetoid cerebral palsied subject are illustrated in Figure 1.

Kinesiological Analysis from Photographic Observations

Onset of the Preparatory Forward Swing. The first frame in Figure 1-A shows the position spontaneously assumed in grasping the bowling ball preparatory to throwing. The arm used is approximately perpendicular to the floor. The head is turned to the left side, so as to bring the ball into view. The cerebral palsied patient uses vision to assist in the placement of the fingers in the holes provided in the bowling ball. The left foot rests firmly on the floor. Except for the positioning of the right arm and leg, the pose is comparatively natural and graceful.

Frames 2 to 8 on the profile and front view of Figure 1 are roughly equivalent points in the movement cycle. By the time the first discernible movement of the ball forward in the sagittal plane can be detected, the head has swung to a position of hypertension. This probably facilitates the stiffening of the forelimb engaged in the throwing act. The head usually appears also to have rotated slightly away from the active side, as though to facilitate the anticipated flexor movement. The opposite arm is abducted to help counteract the influence of the ball on the center of gravity of the body as a whole.

Forward Swing. The preparatory swing, per se, is characterized by a straightening of the vertebral column as the ball comes forward. The head is less extended than previously. Before the end of the swing has been reached, the head turns toward the moving side in anticipation of the backstroke. This interesting phenomenon of a symmetric head positioning was most clearly defined in the contralateral profile and the front views, in both of which the right sternocleidomastoid was visibly contracted. In the side view the whole belly of the muscle could be traced. The thighs, already adducted in the starting position, continue moving inward until the knees come almost into contact. In general, the forward swing appears to put little stress on the neuromuscular machinery. The task seems to be accomplished easily and smoothly.

Backstroke. Humeral advancement reverses without any apparent break in the prescribed throwing cycle. The ball drops easily, aided by gravity. The vertebral column begins to flex again and the head moves into more marked extension. Athetosis of the contralateral arm usually augments at this time. That the stress mounts during the terminal phase of the backstroke is easily seen. By the end of the swing which precedes the power stroke, the thoracic spine has flexed sharply and hyperextension at the atlanto-occipital joint is extreme. The head has rotated away from the throwing arm in anticipation of the shoulder joint flexion which is to follow. The left sternocleidomastoid stands out as a well-defined band in the ipsilateral profile view. The right wrist is flexed. The fingers of the right hand are extended and the thumb is

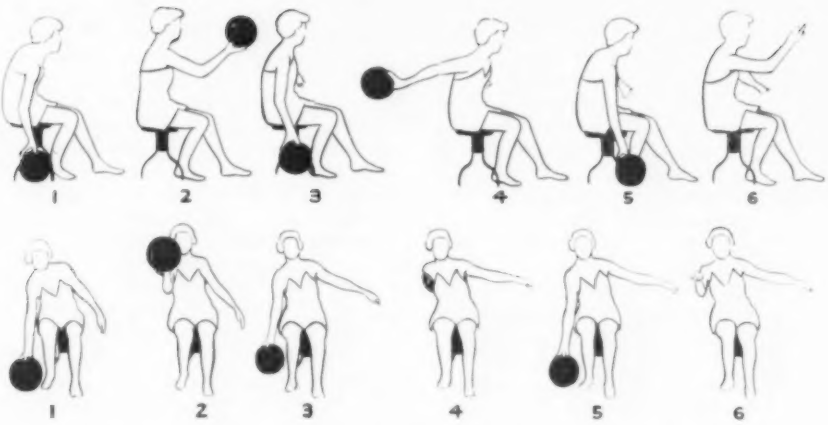

FIG. 2. Key positions in the bowling throw of the normal control subject.

sharply adducted. This is a typical athetotic hand posture, similar to those described by Herz[1] in his moving-picture analysis of involuntary movements. The thighs, which had started to abduct at the beginning of the backstroke, are now widely separated. The mobilization of available muscle power for supreme effort is depicted in every line of the pose caught and frozen by the camera.

The position of the right upper extremity is the reciprocal of the left during the backstroke, except that abduction at the shoulder joint dominates rather than flexion. This compensates for gravitational stresses introduced by the weight of the ball being swung at the end of a long lever. Lateral stability is less secure than anteroposterior in the sitting posture. The thighs are widely separated and the right foot is inverted, as though to increase coronal plane security.

Power Stroke. The ball is released after the arm has passed ten or fifteen degrees beyond the vertical. Back flexion and neck hyperextension reach their maximum at this point. The head is usually still turned away from the throwing arm to facilitate the flexion that drives the limb forward. The thighs, which had been abducted, come together again. Involuntary movement of the right hand reaches its peak during the interval of maximal stress and immediately thereafter.

Follow-Through and Recovery. Once the ball is released, the throwing arm continues to swing forward and then returns to the side. The pattern appears to be smoothly controlled and harmonious. The right arm recovers more slowly than the left. It relaxes gradually and derotates after the throwing arm has recovered.

The most striking feature in every throw made by M. A. is the comparative normality of the behavior of the throwing arm. No involuntary motions obtrude to distort the pattern of that extremity. The contralateral limb, which played no direct role in bowling, showed some dyskinesia. Thus, unilateral exercise, while carrying a considerable load at comparatively high speed in a competitive atmosphere, did not disrupt coordination. Rather, it appears to have suppressed discordant movements and/or mobilized reserves of strength and control, normalizing neuromuscular behavior.

No attempt was made to determine whether a cerebral palsied patient as disabled as M. A. could acquire sufficient strength and skill to participate effectively in the sport of bowling. The experience was astonishingly dynamogenic. The use for therapeutic purposes of a type of exercise enjoyed by normal men and women had a profound psychological effect.

It would be a mistake to give the impression that the performance of this athetoid cerebral palsied patient is classifiable as normal because the pattern of activity of the throwing arm appears to be so agreeably consonant with expected behavior. The frank abnormality in the total response can be seen by comparing Figure 1 with Figure 2. The performance of the pathological subject now looks labored. The magnitude of the effort required to achieve what the normal subject does with graceful ease is self-evident.

The most biologically significant difference in the response of the normal and pathological subject is the degree to which attitudinal reflexes are operative in the latter. These are tonic reactions evoked by head movements, in consequence of which ". . . the whole body musculature is integrated for a combined and highly adapted function."[2] Thus, Magnus points out that good pictures and statues are satisfying and give the impression of being natural if the disposition of the body parts is in accord with the laws of the attitudinal reflexes.

Much of the posturing of the pathological subject seems to be tied to head positioning. Hyperextension of the upper cervical spine fluctuates directly with the severity of the effort demanded during the different phases of the throwing cycle. To achieve this and yet keep the line of sight focussed on the target at the end of the alley, the vertebral column flexes strongly; the spine curls, but the head retains its normal poise. The resultant atlanto-occipital and upper cervical spine movement is extreme indeed.

In 1951, McCouch, Deering, and Ling[3] localized the receptors for the tonic neck reflexes in the upper joints of the neck, especially the atlanto-axial and atlanto-occipital. In the quadruped, dorsiflexion of the head stiffens the forelimbs and causes the hind quarters to sink to the ground. It is well known that remnants of this archaic response emerge at the least provocation in the individual with brain damage. Presumably the attitudinal reflexes reinforce a distribution of tonus which is obligatory to the successful performance of the bowling act.

Rotatory movements of the head were less conspicuous than the dorsiflexion described, but they could be picked up in the frame-by-frame examination of the cinematograms. It was of considerable interest to note that they invariably precede the movement known to be facilitated by the head turning, observed as though anticipating what is to come. The shifts in tonus that result are like those known to occur during ballistic movement.[4]

Close and careful inspection of the head position of the control subject indicated that it remained virtually unchanged during the execution of the bowling throw as modified to expedite performance by the disabled. No sagittal plane variations in flexion or extension occurred. Rotatory movements were detected but these were rare, and when observed, were always minute.[1] Those identified were invariably in a direction consonant with the operation of the attitudinal reflexes.

Work done previously by Hellebrandt, *et al.*[5] yielded unequivocal evidence that head positioning, contrary to archaic quadrupedal patterning, inhibits the mobilization of the muscular resources of the normal subject. Volitional head turning, in harmony with the tonic neck reflexes, was facilitating. The head and the limbs appear to be yoked together irrevocably. The head leads and the limbs follow in an invariable manner. In the disabled individual, plagued by weakness incidental to deficits in neuromuscular training and experience, dependance on these built-in augmenters to step-up performance is to be expected. To suppress these ancient facilitatory devices may deprive the handicapped individual of benefits accruing from the spontaneous operation of a compensatory type of behavior.

Mechanical analysis of the bowling swing executed by the normal and pathological subjects revealed a number of significant differences. One of the most marked and persistent was the extent to which M. A. kept the throwing arm abducted. The shoulder joint abductors were probably stronger than the muscles which advance or depress the humerus. Certainly they operate continuously during ambulation, to assist in the maintenance of a precarious balance.

The normal subject moved the ball forward on the preparatory swing by flexing the forearm first and then advancing the humerus. Apparently the athetoid cerebral palsied patient could accomplish this only by stiffening the appendage at the elbow joint and then advancing the limb in toto. The range of motion, both forward and back, was also grossly limited in M. A. This is due probably to weakness. The lower backswing means a slower momentum and a less effective "beat" stroke.

Electromyographic Kinesiology of the Bowling Throw

Each subject threw the bowling ball between 35 and 40 times for electromyographic purposes. Because of limitations in space, and the risk of damage to the copper screening of the electromyographic cage, it was necessary to reduce the power of the "beat" stroke. This should be remembered when the electromyograms are examined.

The main features of the patterned action of the muscles used to actuate the throwing arm are illustrated in Figure 3. Unlike the throws executed by the control subject for photographic purposes, this multiple lead electromyogram illustrates a completely normal, so-called "straight

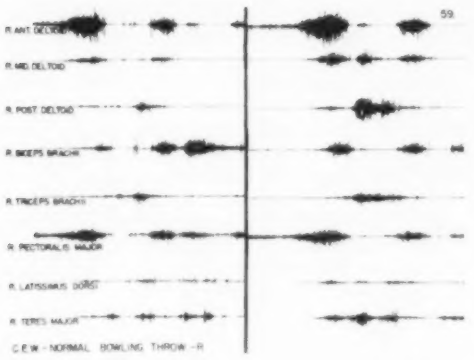

FIG. 3. Electromyograms of two normal bowling throws made by the control subject in the usual standing position with a four-step approach.

ball," executed in the standing posture with a traditional four-step approach. The ball is held in front of the chest in the starting position and is steadied by the fingers of the left hand. There is considerable tension in the anterior deltoid and the pectoralis major during the readiness interval. At the onset of the throw, the arm swings forward under the influence of activity by the anterior deltoid and the pectoralis major. The biceps participates late in this phase of the cycle. The antagonists to humeral advancement offer a slight modulating action. Vigorous contraction of the posterior deltoid, triceps, and teres major activate the backstroke. The latissimus dorsi contributes relatively little to the pattern as executed by this subject. A return of activity to the muscles which advance the humerus marks the onset of the power stroke. The middle deltoid shows a discrete burst of activity in all three phases of the movement cycle to keep the arm sufficiently abducted for the ball to clear the body in its sweep through the sagittal plane. Once the ball has picked up momentum, it seems that less muscular effort is required to direct its course through the path prescribed than to initiate the movement, but this is without doubt an artifact, due to volitional reduction in the force of the "beat" stroke, for the reasons already cited.

Figure 4 illustrates the sequential action of the same muscle groups when the athetoid cerebral palsied patient bowls from the sitting posture. The action potentials are, first and foremost, appreciably larger in amplitude than those manifest by the control subject, and the pattern has lost some of its discreetness. The middle deltoid, biceps, triceps, pectoralis major, and latissimus dorsi fire erratically in anticipation of the preparatory swing. The athetotic subject is struggling to keeping the throwing arm extended and away from the body. Turner, Perlstein, and Elam[6] found that it was difficult or impossible to get electromyographic silence at rest in the athetoid patient.

The bowling pattern can be identified without difficulty in every multiple lead electromyogram obtained on M. A. The anterior deltoid, biceps, and pectoralis major advance the humerus. It is depressed by the posterior deltoid, triceps, and latissimus dorsi. As in the normal subject, the power or "beat" stroke is characterized by an unexpectedly small barrage of activity in the shoulder joint flexors, due to volitional suppression. The middle deltoid dominates the picture in M. A. It fires strongly and continuously during all three phases of the throwing cycle. This confirms what is seen in the cinematograms of the athetoid cerebral palsied patient. One of the most characteristic and constant abnormalities manifest was the degree of abduction maintained throughout the throw.

The teres minor helps to keep the humerus laterally rotated. In electromyograms sampling the infraspinatus, this muscle functioned strongly and synchronously with the teres minor to help keep the throwing arm moving straight forward without rotation. Subject M. A. had great difficulty achieving the purity of motion demanded to throw a "straight ball." She tended persis-

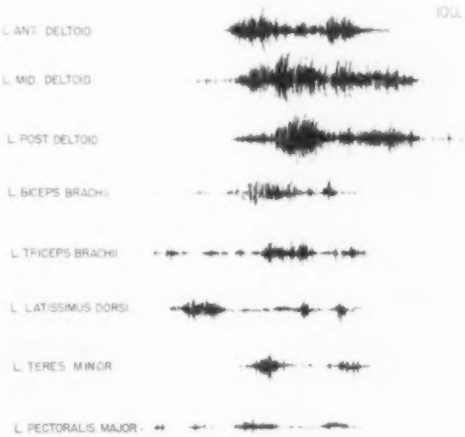

FIG. 4. Electromyograms of "straight ball" thrown from the sitting position by a patient with athetoid cerebral palsy.

tently to pronate the forearm and medially rotate the arm as the extremity swung forward.

Activity was consistently greatest in the lowest division of the three parts of the trapezius. This was strongly active during all phases of the cycle, presumably to stabilize the scapula. The upper trapezius fired more discretely, usually when the humerus advanced in preparation for the throw, and especially on the "beat" stroke. It could be seen bulging in many of the front view cinematograms.

An example of imbalance in the activity of the sternocleidomastoids is illustrated in Figure 5. The ipsilateral wrist extensors showed continuous strong contraction, reasonably well maintained. Co-contraction of the wrist flexors was present invariably.

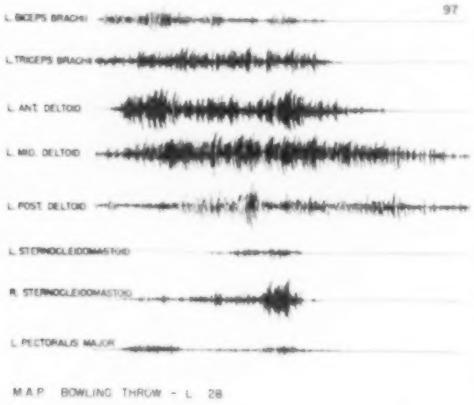

FIG. 5. Electromyograms of another bowling throw by the cerebral palsied subject with the electromyogram paper moving at higher speed.

When muscle groups of the contralateral side were sampled during a regular throw with the left arm by the athetoid cerebral palsied patient, the middle deltoid again dominated the picture, attesting to the abduction spontaneously evoked to equilibrate gravitational stresses and to maintain balance. Wrist flexion was also consistently present as the reciprocal of the strong extension demanded on the throwing side by the manner in which a bowling ball is held.

Agonists and antagonists fire simultaneously in virtually all phases of the throwing cycle as executed by the athetotic subject. The amplitude of the action potentials fluctuates, mounting in one member of the pair as it subsides in the other, only to reverse at the instant the movement changes direction. This does not appear to be abnormal, except perhaps for the degree of co-contraction. No muscle can act strongly without collateral effects on other muscles. Many years ago, Duchenne[7] emphasized that in order to move a part, all the musculature belonging to it must cooperate, including the antagonists. Subsequently, Beevor[8] expressed the same view. Thus the co-contraction of antagonists characteristic of athetoid cerebral palsy may be no more than an exaggeration of normal behavior.

SUMMARY

One adult female patient, suffering from a moderately severe athetoid cerebral palsy of congenital origin, was systematically trained to throw a bowling ball from a comfortable sitting posture. The shoulder ergograph was used to expedite the learning of the basic throwing pattern. After kinesthetic awareness had been aroused, training and experience were extended to include the throwing of a ten-pound bowling ball fitted to the left-handed grasp of the disabled subject. After approximately one month of practice, skill, strength, and endurance had developed sufficiently to warrant cinematographic and electromyographic study of the bowling throw. Control observations were made on one normal adult female. Kinesiological analysis was based on a frame-by-frame study of motion pictures taken from the front, back, right, and left sides. To aid in the identification of key cue positions, more than 1,000 consecutive motion-picture frames were enlarged to 3.5 inches by 5 inches. An eight-channel ink-writing oscillograph was used to record action potentials from various combinations of the neck, shoulder, elbow, and wrist joint muscles of the throwing or the contralateral side, using surface electrodes. The evidence suggests that:

1. A bowling ball may be thrown by a patient suffering from athetoid cerebral palsy of moderate severity.

2. No involuntary motions distort the movement pattern of the throwing arm.

3. Exercise stress evokes attitudinal reflexes which appear to facilitate performance.

4. Similarities in the neuromuscular patterning of the normal and the cerebral palsied subject are more conspicuous than abnormalities in behavior.

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Physical Therapy as Related to Peripheral Nerve Lesions

Robert J. Hickok, B.S.

The use of physical therapy in the management of peripheral nerve lesions has been well-accepted practice for many years. Interest in this area reached an apex during World War II when an unparalleled amount of clinical material provided the stimulus for extensive clinical investigations. In 1945, two concise monographs [1, 2] were published cataloging these war time experiences. In each case, physical therapy played a prominent role in pre- and postoperative management. Subsequent work by Bunnell [3] on dynamic splinting and by others on the refinement of electrodiagnostic and electrotherapeutic measures has further entrenched physical therapy as an integral part of a sound treatment procedure.

The classic physiological changes that occur in both nerve and muscle after a peripheral nerve section have been well described elsewhere [4, 5, 6] and will not be included in this discussion. This paper will confine itself to those physical therapy modalities that have proved successful in both diagnosis and treatment of peripheral nerve lesions at our institution. It should be further pointed out that physical therapy is purely an adjunctive treatment, and that, in most cases, immediate and successful surgical repair must be effected before physical measures may be considered.

From the Jewish Hospital of St. Louis, Division of Rehabilitation.

DIAGNOSTIC PROCEDURES

1. *Manual Muscle Testing.* This technic, so carefully developed to a high degree of skill by physical therapists, is often lost to the examining physician who may make a cursory examination during his neurological evaluation and may not consider more extensive testing to be of value. Muscle testing is particularly useful in nerve injuries not associated with open wounds and may provide an early, accurate assessment of nerve involvement. One method that might add stature to this procedure is to adopt a recording form that graphically displays the brachial and lumbo-sacral plexuses. These forms lend themselves to quick accurate reviews, and, in addition, the results of electro-diagnostic tests may be included.

2. *Routine Electrical Testing.* Erb's classic test first described in 1883, is by far the most widely used electrodiagnostic tool. Based on the simple principle that normally innervated mus-

cle will respond to a tetanizing current and denervated muscle will not, the test provides a rapid qualitative measure of nerve-muscle involvement. Subsequent testing with a direct current in which normally innervated muscle responds in a quick twitch-like response, and in which denervated muscle reacts in a sluggish worm-like contraction, completes the test. This test, because of its utter simplicity, is sometimes overlooked by those who consider themselves sophisticated in electrical testing, or sometimes it is administered so poorly as to be of little value. Our experience has been that changes in skin impedance, plus lowered pain thresholds caused by trauma and loss in muscle bulk, all tend to diminish the textbook clarity of this procedure. Effective use requires complete understanding of the generator being used; and it requires experience in the careful observation and interpretation of reactions as they occur.

3. *The Strength-Duration Curve.* Of the battery of tests that became available following the Second World War, one has survived the rigors of the laboratory and rather extensive clinical usage to become one of our better known electrical tests. This is the strength-duration curve. Recognizing that nerve and muscle are both excitable tissue, and that response depends on the strength of the stimulus and its duration,[7, 8] the strength-duration curve obviously is the relationship of these two factors.

At Jewish Hospital we use an instrument that delivers impulses beginning at 1,000 milliseconds and scaling down to .1 of a millisecond. The intensity of current for minimal response in normally innervated muscle is the same over a broad range of pulse durations, with increase being noted only at very short pulse durations (Curve C, Fig. 1). The excitability curve for muscle is similar in shape to that of nerve with a marked shift to the right, rising sharply with no response seen at shorter pulse durations (Curve A, Fig. 1). During recovery (Curve B, Fig. 1), there is a characteristic "kinking," or discontinuity which indicates that elements of both nerve and muscle are responding. Strength-duration curves have many advantages as a percutaneous testing procedure. When taken serially, they may plot neurotization progress or lack of it. Certainly they provide a more comprehensive picture than routine electrical testing; and thus they deserve a prominent place as a diagnostic procedure in peripheral nerve lesions. However, strength-duration determinations demand a rigorously standardized testing procedure; they require extreme care in determining the often illusive rheobase, and relate information only about the superficial muscles being tested.[7] Thus, to be a reliable clinical tool, strength-duration plotting must be made with extreme care in a laboratory atmosphere.

4. *Chronaxy Determinations.* The chronaxy is defined as the minimum time required to excite tissue when an impulse is twice the rheobasic value. Since both the rheobase and chronaxy are merely important points on a full strength-duration curve (Fig. 2), we have largely discarded chronaxy determinations. Other investigators[9] have found them accurate in localizing nerve root lesions and peripheral neuropathies. The obvious advantage of chronaxy determinations is that, with adequate instrumentation, they can be determined quickly, thus permitting the examination of more muscles in a given time period.

5. *Electromyography.* Electromyography, to date, has been largely confined to large medical centers, thus limiting its availability as a clinical procedure. For the past year at Jewish Hos-

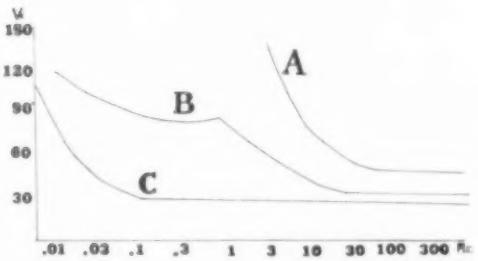

FIG. 1. Strength-duration curve.

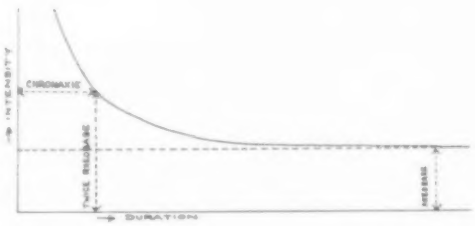

FIG. 2. Chronaxy determination (strength-duration curve).

pital, electromyography has been offered as a clinical procedure in the Rehabilitation Division. Physical therapists have been supplying assistance for this service. Significant electromyographic changes that occur following a peripheral nerve lesion are as follows:

a) There is complete absence of motor unit activity upon voluntary effort.

b) Fibrillation potentials appear in muscles that are normally electrically silent. The fibrillation potential appears only when degeneration of the nerve trunk has occurred. It occurs at needle insertion [10] or it is felt by some investigators to be present spontaneously at rest. Fibrillation potentials of denervation represent one of the most outstanding clinical findings available to the electromyographer. The visualization on the oscilloscope of thin monophasic and diphasic spikes, ranging from 10 to 300 microvolts of 0.5 to 2.0 milliseconds duration, and the characteristic sharp, high-pitched click heard when the sound is amplified on a loudspeaker, are quickly identified by the experienced electromyographer as denervation fibrillation.

c) The first electromyographic evidence of nerve regeneration is the appearance of polyphasic motor unit potentials, varying from 50 to 100 microvolts of 20 millisecond duration.

In our experience, electromyographic records, when interpreted by a physician with experience in this area, provide an objective picture of peripheral nerve pathology. They are, perhaps, the only means whereby lesions may be accurately localized. When pain, restriction of motion, or loss of muscle bulk render other tests inconclusive, electromyography may provide the sole means of diagnosis. This occurred recently at Jewish Hospital in a 78-year-old woman who suffered a sub-corocoid dislocation of the left humerus. The dislocation was successfully reduced immediately and the patient was admitted to the hospital. Over the next three weeks the attending physician suspected a lesion of the axillary nerve. Pain, swelling, and subsequent immobility rendered other diagnostic procedures inconclusive. An electromyogram taken one month after injury revealed fibrillation potentials (Fig. 3), thus confirming the diagnosis. Follow-up electromyographic records taken at monthly intervals first revealed polyphasic motor units (Fig. 4); and, later, normal motor unit activity was elicited (Fig. 5).

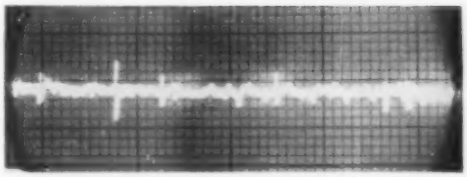

FIG. 3. Electromyogram (fibrillation potentials)

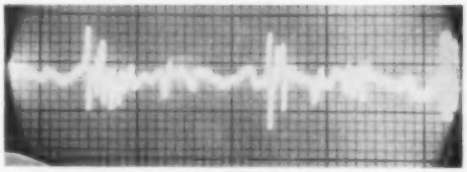

FIG. 4. Electromyogram (polyphasic motor units)

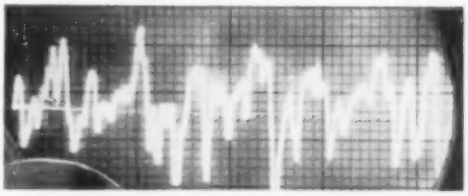

FIG. 5. Electromyogram (normal motor units, poor interference pattern)

THERAPEUTIC MEASURES

The cardinal objectives of a therapeutic program for peripheral nerve lesions are deceptively simple. We strive to retain joint mobility, prevent deformity, reduce edema (when present), and to retain the denervated muscle in an adequate nutritional state for eventual reinnervation. These ends are accomplished by the selective use of the following procedures:

1. *Passive Motion.* A militant program of passive motion of the paralyzed part through complete range-of-motion, twice daily. The patient should be instructed to carry out this procedure himself at the time of his discharge from the clinic.

2. *Orthetic Devices.* Supportive devices may range from a short-leg brace with a Klenzak ankle joint for a peroneal nerve lesion to a simple sling support for an axillary nerve involvement. Supports gain added significance in lesions involving the intrinsic and extrinsic muscles of the hand. Bunnell[3] felt that hands, because of their accurately fitting and smoothly gliding parts, plus a ready inclination to swelling and fibrosis, must always be splinted with

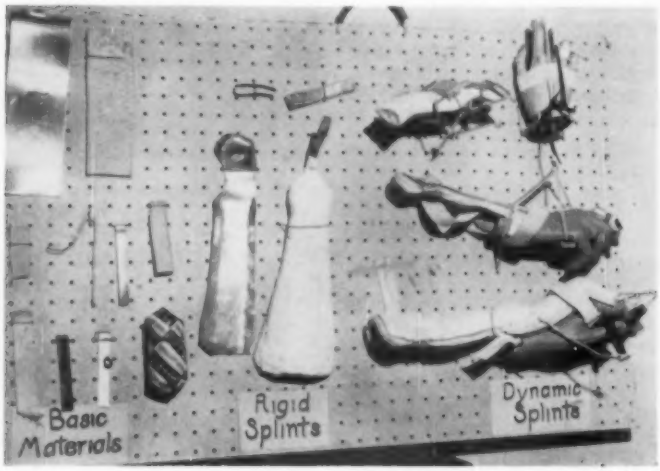

FIG. 6. Adapted dynamic and rigid splints.

a dynamic splint. To be dynamic a splint must provide for a balanced position of function for the paralyzed parts, and must permit active function of the unparalyzed segments. Dynamic splints can easily be constructed from light aluminum, plaster, rubber bands, and felt (Fig. 6). This illustration represents the work of a local industrial surgeon who prefers the versatility of his own devices. Dynamic splints, universally known as "Bunnell" splints, are commercially available, and although they resemble one's concept of an elaborate mousetrap, they do an adequate job.

3. *Therapeutic Electrical Stimulation.* The use of therapeutic electrical stimulation on denervated muscle has long been a controversial subject. In 1942, Gutman and Guttman[11] demonstrated retardation of atrophy in rabbits by electrical stimulation; however, subsequent work by Pollock, *et al.*[12] could not duplicate these results in the cat. The few studies carried out in man by Wakim [4] and others have consistently demonstrated a significant retardation of atrophy by daily electrical stimulation of denervated muscles. It is felt by some investigators that electrical stimulation is more effective when muscles are placed on stretch to develop maximum tension during stimulation.

Optimal levels for frequency and duration of treatment have not been clearly established. However, most authorities feel that three or four brief periods of electrically-induced muscular activity each day will accrue maximum benefits in retardation of atrophy.

Obviously, stimulation should be used only if there is strong indication that reinnervation will occur. It is of particular value in lesions that will require a year or more for neurotization to occur, since fibrotic dedifferentiation of muscle fibers may be well advanced by this time.

Since this form of treatment may extend over many months and require multiple daily sessions, various stimulators powered both electrically [13] and by batteries [14] are available for use in the home. These machines are necessarily quite simplified and, with a minimum of instruction, patients can successfully apply their own stimulation. This obviously is a realistic answer to the prohibitive cost of daily treatments in a department.

ADDITIONAL PROCEDURES

1. *Massage.* Most clinical programs include massage, particularly for edematous hands. We have been quite selective in using massage. Possibly this is just a reflection of the decline of massage generally, as a therapeutic procedure, which has been pointed out by Jacobs.[15]

Indeed, the physiological basis for massage is quite realistic; its favorable influence on venous and lymphatic flow is well known. Suskind [16]

and associates compared massage and electrical stimulation and found that whereas electrical stimulation maintained greater muscle mass, the massaged muscle had better retention of strength per unit mass. They concluded from this that these treatments should be combined for optimal benefits.

2. *Heat.* Frequently, either moist or dry heat is utilized cautiously to reduce skin resistance, prior to electrical stimulation. We have been quite reticent to heat more extensively in peripheral nerve lesions, in deference to the concomitant anesthetic areas and danger of burning. Thus, we usually avoid use of this modality.

3. *Exercise.* Exercise programs, beyond the use of simple passive motion, will vary greatly, depending on the type of lesion and the degree of recovery anticipated. Generally, they include the following elements:

a) *Muscle Re-education.* Muscle re-education by manual keying of tendons or with the assistance of electrical stimulation should be utilized during the early phases of recovery to overcome alienation and assist early active function.

b) *Active Assistive and Active Exercise.* Active assistive and active movements should be encouraged as progress occurs. Substitution movements should obviously be avoided during this period.

c) *Resistance Exercise.* An element of caution should be interjected here regarding the overambitious use of heavy resistance exercise on partially or recently innervated musculature. Over the past several years we have noted several patients with recovering lesions who lost strength on an exercise program designed for rapid restoration of power. Recent work by Bennett [17] on overwork fatigue in postpoliomyelitis patients indicates that if exercises of this type are carried out over a long period of time irreversible changes may occur. Thus, for precautionary purposes we generally reduce resistance exercises initially to less than a 10-RM level easily tolerated by the patient.

SUMMARY

A sound, physical therapy program may provide the industrial surgeon with invaluable assistance in the care of lower motor neuron disease. It may be the only source of specific diagnostic data in stretch injuries of a plexus or as indicated previously in nerve lesions associated with dislocations. Appropriate bracing and exercise will prevent the secondary changes of neglect from occurring. Additional testing may eliminate the period of uncertainty as to whether the nerve is undergoing regeneration, thus providing the surgeon with a clear prognostic picture previously unobtainable. In lesions that may require a long period of time for regeneration, the use of therapeutic electrical stimulation appears to be realistic in order to retard fibrotic changes.

Obviously, in cases where recovery is seriously doubted, the excessive use of treatment is not conscionable. However, to insure maximal early recovery, physical therapy must be considered of value.

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Physical Therapy Program for a Patient with an Austin-Moore Prosthesis

Sachi Taniguchi

On September 25, 1959, a spry 61-year-old widowed female patient fell from a ladder while working at home. She was hospitalized in Los Angeles County General Hospital with complaints of a painful right hand and leg. X-rays revealed an impacted Colles fracture of the right wrist and a displaced, transcervical fracture of the right hip. The right leg was placed in Russells' traction, and a sugar-tong cast was applied to the right wrist.

Three days later, an open reduction of the transcervical hip fracture was performed and four Haggie pins were inserted as fixation; also, a closed reduction of the Colles fracture was performed and a below-the-elbow cast was applied. The patient's postoperative course was satisfactory; and three days following surgery a physical therapy program was started. Therapy consisted of resistive exercises to maintain and increase strength in the uninvolved extremities, and active range of motion exercises to the fingers and shoulders of the fractured forearm. In a short time, the patient was up in a wheelchair and learning bed-to-wheelchair transfer activities.

However, re-examination by x-rays on November 2 revealed displacement of the femoral neck fracture. The patient was then presented in the orthopedic clinic at which time the insertion of an Austin-Moore hip prosthesis was recommended. In surgery the following day, through a posterior approach, the Haggie pins were removed and an Austin-Moore prosthesis was inserted. The operative report indicated slight instability of the prosthesis due to difficulty in achieving an exact fit with the acetabulum. The patient was returned to the ward with the right leg in Hodgen-Pierson suspension to maintain a position of hip flexion, abduction, and external rotation.

* From Orthopedic & Physical Medicine Services, Los Angeles County General Hospital, Los Angeles, California.

Three days later the patient complained of pressure over the head of the right fibula and showed evidence of peroneal nerve compression, possibly due to the prolonged pressure on the leg in suspension. Therefore, all pressure was removed from this area. At this time, sensation was intact, though motor function was impaired. The patient was followed closely to determine the extent of the damage.

On the fourth postoperative day, intensive static contractions of the quadriceps and gluteal muscles were started, and resistive exercises to the uninvolved extremities were resumed. One week after surgery, the cast was removed from the right wrist, and active-assistive range of motion was begun.

On November 10, the suspension was removed from the right leg because of breakdown of the skin over the lateral fibular area; position of the leg was maintained with a footboard, sandbags, and hip pillows. At this time, no recovery of the peroneal nerve was noted.

At this point, the following exercise program was followed:

1. *Right Hip*
   a) flexion and extension.
   b) abduction with use of a skate board.
2. *Right Knee*
   a) flexion and extension.
   b) active resistive exercises.
3. *Ankle*
   a) passive range of motion.

When the foregoing therapy was begun, the patient demonstrated 'poor' strength throughout hip and knee musculature, 'zero' ankle dorsiflexion and toe extension, and 'poor-plus' plantar flexion.

On November 18, the patient began ambulation with parallel bars, bearing partial weight on the right foot, as tolerated. She wore an ace bandage around her right wrist for support. The patient appeared to bear from forty to fifty per cent of her body weight on the right foot with no pain. An improvised dorsiflexion assist apparatus was used as the patient demonstrated difficulty in clearing the right foot because of right hip weakness combined with "drop foot." The apparatus consisted of a leather calf-cuff with an elastic band in the front which was tied to a tennis shoe to hold the foot in dorsiflexion. The need for this device was reported to the physician and he referred the patient to the brace clinic for consideration of a short-leg brace.

On November 21, the sutures were removed from the incision in the hip and a pressure blister was noted over the right heel. The pressure areas on the heel and over the head of the fibula began to heal and the progress was closely observed.

By December 3, the patient had progressed to independent ambulation in a walker with approximately seventy-five per cent weight bearing on the right. During this time, she improved steadily in strength and range of motion through use of the skate board, quadriceps exercise boot, and pulleys to develop strength and range of motion of the knee muscles. On December 4, a gross examination of right hip and knee revealed 'fair' to 'fair-plus' strength throughout. Her right wrist showed 'good-minus' strength and essentially normal range of motion. Therapy was continued with the addition of galvanic electrical stimulation and muscle re-education to all muscles innervated by the peroneal nerve.

On December 8, the patient received her right short-leg brace with lateral dorsiflexion assist attachment and orthopedic shoes. Now the energetic patient was started on crutch ambulation with full weight bearing, as tolerated. A four-point gait was taught and the patient experienced no pain on bearing about ninety per cent of her weight on the right at this time. She soon learned to be independent in essential crutch activities and was discharged from the hospital on December 15, 1959.

This patient was not discharged from physical therapy; she was scheduled to report three times weekly for continued treatments. She kept appointments regularly and an enthusiastic report was always given as to how well she was accomplishing her daily activities. But, now that she was on her feet many hours of the day, some new problems developed. The right foot and ankle became extremely edematous. Irritation from the calf-cuff of her brace caused another breakdown in the healing pressure area. The wound was debrided and the leg was treated with whirlpool; and the patient was referred back to the brace clinic for possible alteration of the brace. In the clinic, a decision was made to discontinue use of the brace temporarily and to lower the calf-cuff to prevent further irritation. The pressure sore healed slowly and when the patient was able to use her short-leg brace again, she progressed to ambulation with one cane.

On March 1, an electromyogram revealed "eighty per cent fibrillation with a few normal motor units on voluntary contraction of the muscles innervated by the right peroneal nerve." Periodic muscle tests were made of the involved muscles while the patient continued resistive exercises to all four extremities; electrical stimulation and muscle re-education to involved muscles; and gait training.

The first "flickers" of function of the anterior tibialis and peroneus longus muscles were noted on February 19; and, on April 1, both muscles tested 'fair-plus.' The long toe extensors were 'fair-plus,' also. The peroneus brevis was noted to lag in return and demonstrated only 'poor' to 'fair-minus' strength.

At the present time (May 15, 1960), the patient is able to walk about her home without the cane or short-leg brace; she climbs stairs normally with the aid of a cane, and comes in for her bi-weekly treatments by streetcar! She is very proud of her ability to do all her housework, cooking, shopping, and washing. Her day begins at 6:00 A.M. and ends at 10:00 P.M. She walks two and one-half blocks to the market and back, wearing her brace only "for safety's sake." A former dressmaker by trade, she reports with pleasure that she also spends four to five hours daily working on dress alterations.

The *Review* invites case reports from physical therapists who have followed an interesting course of treatment with or an unusual response to treatment by patients having one of the conditions listed below.

Dislocation of coracoclavicular joint
Ulnar neuritis
Cervical spondylosis
Congenital dislocation of the hip
Tennis elbow
Myocardial infarction
Basketball injuries
Football injuries

Note: Suggestions for preparation of case reports were published in the October 1957 issue of the *Review*, pages 666-667. Reprints of the suggestions may be requested by writing to the *Physical Therapy Review*.

Adapted Parallel Bars

Mary F. Westhoven, Captain, AMSC*

Parallel bars are useful and necessary equipment, but in a small clinic where their use as well as floor space is limited, their bulk presents a decided problem. Although commercial fold-away units are available, they are relatively expensive.

The following adaptation was designed and constructed to provide low cost parallel bars that will not occupy floor space when not in use, but which can be quickly and easily assembled when needed.

* Physical Therapist, U. S. Army Hospital, Fort Hood, Texas.

Fig. 1. Assembled parallel bars.

Two treatment tables are utilized as a base for the bars. The tables (Fig. 1) are adjustable in height and are equipped with casters that lock in place. Thus, a good range of height and width adjustment for the bars is provided.

The bars are lightweight aluminum poles. In this case, the poles from a standard U.S. Army field litter were utilized. These are 7½ feet long, 1½ inches in diameter and have rounded ends. When in place they extend beyond the treatment tables and have proved to be adequate in length.

Two brackets (Fig. 2), constructed by an orthopedic brace man, were permanently attached to each pole. The brackets fit over half-inch bolts which are screwed through and fastened in place on the tables. Assembling the bars involves sliding the brackets onto the bolts and fastening them with winged nuts. The bolts, when left in place on the tables, have not interfered with normal use of the treatment tables.

Suitable lengths of common pipe could be substituted for the litter poles but would be heavier and therefore more difficult to assemble and dismantle. While adjustable-height tables are desirable, the average, stationary-height treatment table is adequate for most adult patients.

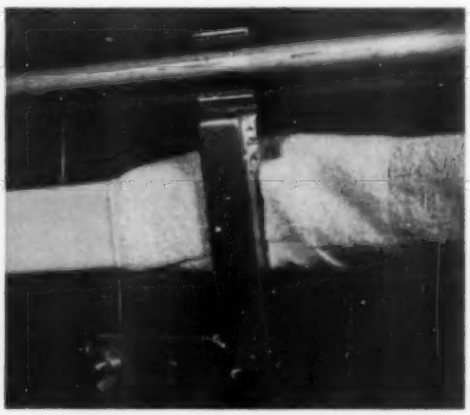

Fig. 2. Bracket attachment to table.

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Editorial

On Reading Other Journals

"To what other professional journals do you subscribe?" This was the last question on the recent *Physical Therapy Review* questionnaire. A tally of the first 1000 replies revealed that only one-half of the members subscribe to at least one other professional journal. It is not surprising to find that the *Archives of Physical Medicine and Rehabilitation* leads this list of journals with 300 subscribers. The *American Journal of Physical Medicine* is second with 51 entries. These were followed by the *Journal of Rehabilitation*, *Rehabilitation Literature*, the *Cerebral Palsy Review*, *American Journal of Occupational Therapy*, and the *Journal of the American Medical Association*, each of which had 15–30 subscribers. The names of more than 100 periodicals appeared, including journals on education, orthopedics, science, nursing physiology, public health, and hospital administration, but with insignificant frequency.

This report introduces in a most convenient way the theme for this editorial—that we should be reading more professional journals, and more diversified professional literature. We are hearing from all sides that physical therapy must keep pace with the tremendous advances in science and medicine. The Annual Conference in Pittsburgh last year did much to point out the expanding needs for the services of physical therapists, particularly in industry, such as: time-motion studies, human factors engineering, and exercise in a weightless environment.

We are also hearing from key persons concerned about the future of physical therapy, that we must continue to develop a body of knowledge that identifies physical therapy, and that this body of knowledge must be built upon sound, basic principles. This was notably apparent at the APTA-OVR Institute in 1960 where emphasis was made on the need of scientific knowledge for the development of physical therapy. Again, this need was specifically demonstrated recently while listening to a well known neurologist lecturing to physical therapy students. His opening statements were, "Conventional methodology of physical therapy is quite inadequate for the treatment of cerebral palsy. This is due to the lack of understanding of the nervous system." What are we doing about this?

As with any profession, our profession is the collective contribution of the individuals who compose it. Whether we are in the clinical area of physical therapy, in research, or in the teaching field, one important way that we as individuals can expand our knowledge is by reading professional literature, both in our own field and in other fields allied to physical therapy. You are familiar

with the many fine papers published in the *Review*, but we must go beyond this. For instance, have you read the papers on the innervation of muscle which appeared in recent issues of the *American Journal of Physical Medicine*—a symposium including such authors as Eccles, Gutmann, Buchthal, Bauwens, Bourguignon, and Nachmansohn? Have you read the papers on neurophysiology and the treatment of cerebral palsy which recently appeared in the *Cerebral Palsy Bulletin?* Have you read the paper on the effects of lowering the body temperature on the symptoms and signs of multiple sclerosis which appeared in the *New England Journal of Medicine?* These are but three of the many other excellent papers pertinent to the various facets of physical therapy which appear in journals such as the *Journal of Bone and Joint Surgery, Archives of Neurology, Industrial Medicine and Surgery,* the *Journal of Chronic Diseases,* and *Science*. The abstracts section of the *Review* covers these and a hundred other medical and scientific journals. Abstracts, if properly prepared, give the essence of the original article. Only from the original article can we glean the full significance of the author's work and become thoroughly informed.

Reading can be the start of another chain reaction—reading literature in our own field and in other fields, increasing our knowledge, searching for sound basic principles, being stimulated to further study, and perhaps continuing on into research. Only then, shall we be more adequately prepared to forge ahead with other professions, to meet the enormous advances in science and medicine, and to fulfill the expanding needs for the services of physical therapy.

KATHRYN J. SHAFFER
Abstracts Editor, 1957-1960

An American Pioneer In Physical Therapy

Mary McMillan saw the birth and the maturity of her profession and, at an age when most of us have ceased to care, she not only watched over its activities, but, by her lectures and talks, so we are assured, she continued a source of inspiration to younger physical therapists.

It is good for a profession to have its heroes and heroines, and it is better still that we should remember them. The commemorative issue of the *Physical Therapy Review*, (February, 1960) is not merely a generous gesture to the memory of a great woman, but a farsighted step in the establishment of a tradition in physical therapy in which we may all take pride.—*The Australian Journal of Physiotherapy, July 1960.*

EDITOR'S NOTE: Many of the journals of the member organizations of the World Confederation for Physical Therapy, too, gave tribute to Mary McMillan during the past year. The preceding two paragraphs have been excerpted from *The Australian Journal.* To us, these words from "down under" reflect, again, the admiration and respect we tried to portray in our February 1960 issue published in honor of Mary McMillan.

Association News

Herbert F. Underwood died on December 26, 1960, in Vallejo, California. A native of Great Britain, he received his physical therapy preparation at the Field and Morris School of Physiotherapy in London. Following experience in Great Britain and Canada, Mr. Underwood came to the United States in 1950. He had been associated with the Vallejo General Hospital in recent years. He became a member of the Chartered Society of Physiotherapy in Great Britain in 1946, and a member of the American Physical Therapy Association in 1952.

Member Honored by American Medical Writers' Association

Sara Jane Houtz, Research and Educational Consultant, Detroit Orthopaedic Clinic, Detroit, Michigan, received a 1960 AMWA Fellowship during the 17th Annual Conference of the American Medical Writers' Association held in Chicago, November 18–19, 1960. Twenty-two recipients from thirteen states were recognized for "high qualifications, personal and professional, and of established standing as a medical writer, journalist, or publisher."

Chapter News

Delaware

A more serious aspect of the Chapter's Christmas party and meeting was a film presentation and discussion on devices which the speaker, Arthur J. Heather, M.D., has developed. Dr. Heather's "The Helping Hand" was included in this presentation.

Iowa

The Chapter has undertaken a survey to determine the salary range for physical therapists in Iowa and adjoining states. Questionnaires have already been received from forty-three respondees.

Massachusetts

Chapter members who attended the Fall Institute, held November 19, 1960, studied "The Hip." Sub-topics under discussion during the morning session were hip problems in children, including congenital dislocation, septic hip, Legg-Perthe's disease, and slipped capital femoral epiphysis. After an orthopedic surgeon spoke on each topic the physical therapy approach was discussed by several members. In the afternoon session, hip fractures in adults and malum coxae senilis were considered in similar manner.

North Carolina

Station WSOC-TV, Charlotte, is assisting the Chapter in its public relations program for Physical Therapy Week (March 20 to 25, 1961). Persons in public relations work from television, radio, newspaper and commercial art were invited to a luncheon at the station on February 18.

Northern California

The Chapter will be the host for the annual state meeting of California Chapters at the San Mateo Villa Hotel, March 25 and 26, 1961. The Executive Committees and Members from Northern California, San Diego, San Joaquin Valley and Southern California Chapters will gather for business and program sessions.

Ohio—Central District

A local orthopedic appliance company was invited to present the program at the February District meeting. The District has also announced the topics for future meetings.

Ohio—West Central District

The physician who spoke at the January meeting discussed "Skin Grafting." "Physioscope," the Ohio Chapter newsletter which carries news of the Districts, also provides the dates for the District's remaining meetings.

Texas—Coastal Bend District

The District exhibited at the state convention of the Future Nurses of Texas held in the Coastal Bend district in March.

Texas—Heart of Texas District

Plans are under way for the District to be host for the Chapter's annual meeting scheduled for April.

Vermont

Although held in neighboring New Hampshire, the Tri-State Conference on Recruitment displayed the Vermont Chapter's exhibit. The New Hampshire Chapter assisted their sister Chapter in the project.

Washington

"Rehabilitation Education Service Project for Nursing Homes in Washington State," a federal-state sponsored project demonstrating and teaching rehabilitation technics in nursing homes, was presented at the January meeting by six panelists. The panel members represented physical medicine, nursing, social work, occupational therapy and physical therapy. Also among the January activities was a showboat theatre night, one of the Chapter's fund raising projects.

Officer Candidates 1961-1964

Photographs and biographies of candidates for Directors of the Association and for the Nominating Committee will appear in the March issue.

FOR PRESIDENT

Mary Elizabeth Kolb, Instructor, D. T. Watson School of Physiatrics, Leetsdale, Pennsylvania

Association member since 1943

Chapter positions: President, Pennsylvania; Director, Pennsylvania; Secretary-Treasurer, Western Pennsylvania; Chairman, Public Laws Committee, Western District, Pennsylvania; Chairman, Recruitment Committee, Texas

National positions: First Vice-President; Chairman, School Section; Assistant Editor, *Physical Therapy Review*; Member Advisory Committee on Professional Education; Member, Committee on Examinations; Member, Committee to Study Nature and Functions of Department of Professional Education; Member and Chairman, Conference Program Committee

Sarah W. Bassett, Supervisor of Physical Therapy, Boston Dispensary, New England Medical Center, Boston

Association member since 1946

Chapter positions: President, Massachusetts; Chairman, Public Laws Committee, Massachusetts; Secretary, Carolina Chapter

National positions: Director; Member, Adivsory Committee on Chapter Activities

FOR FIRST VICE-PRESIDENT

Jean C. Bailey, Chief Physical Therapist, Milwaukee County General Hospital, Milwaukee

Association member since 1935

Chapter positions: President, Western New York; Secretary, Western New York; President, Carolina Chapter; Vice-President, Carolina Chapter; Chairman, Education Committee, Wisconsin

National positions: Secretary; Member, Joint Committee of the American Hospital Association and the American Physical Therapy Association

Dorothy Page, Director of Center Services, Albany Hospital Cerebral Palsy Center, Albany

Association member since 1943

Chapter positions: President, New York; Director, New York; Chairman, Public Laws Committee, New York; Chairman, Eastern New York District; Chairman, Program Committee, Eastern New York District; Chairman, Public Relations Committee, New Hampshire

National positions: Member, Advisory Committee on Chapter Activities

FOR SECOND VICE PRESIDENT

Frances C. Ekstam, Assistant Professor and Director, Physical Therapy Program, School of Medicine, Indiana University Medical Center

Association member since 1944

Chapter positions: President, Indiana; Chairman, Committee on Legislation, Indiana

National positions: Member, Education Committee; Member, Advisory Committee to the Department of Professional Services; Member, Joint Committee of the American Hospital Association and the American Physical Therapy Association

James M. Bauer, Assistant Professor, School of Physical Therapy, University of Connecticut, Storrs

Association member since 1951

Chapter positions: President, Connecticut; Chairman, Education Committee, Connecticut; Chairman, Committee on Legislation, Eastern New York

National positions: Director; Member, Finance Committee

FOR SECRETARY

Anna J. Janett, Supervisor of Physical Therapy, Fairmont Hospital, San Leandro, California

Association member since 1944

Chapter positions: President, Northern California; Chairman, Committee on Legislation, Northern California; Charter member and Secretary, San Diego, California; Charter member and Secretary, Arkansas

National positions: Recording Secretary, Section on Education

Margaret L. Moore, Director, Curriculum in Physical Therapy, and Chief, Department of Physical Therapy, Section of Physical Therapy, School of Medicine, University of North Carolina, Chapel Hill

Association member since 1943

Chapter positions: Chairman and Co-chairman, Education Committee, North Carolina

National positions: Member and Chairman, Nominating Committee; Education Consultant, National Office Staff; APTA Representative to the Board of the American Registry of Physical Therapists

FOR TREASURER

Anthony De Rosa, Coordinator, Rehabilitation Services, and Supervisor of Physical Therapy, Burke Foundation Rehabilitation Center, White Plains, New York

Association member since 1949

Chapter positions: President, New York; Director, New York; Chairman, Public Relations Committee, Greater New York District; Chairman, Public Laws Committee, Hudson Valley District, New York

National positions: Treasurer; Chairman, Finance Committee; Member, Nominations Committee

Robert J. Hickok, Coordinator, Rehabilitation Division, Jewish Hospital of St. Louis, St. Louis

Association member since 1953

Chapter positions: Vice-President, Eastern Missouri; Chairman, Program Committee, Eastern Missouri; President, Missouri Physical Therapy Association, Inc. (Eastern and Western Missouri Chapters); Vice-President, Missouri Physical Therapy Association, Inc.

Chicago • July 2-7 • The Palmer House

PAST

PRESENT

FUTURE

Chicago—Capital of the Midwest

40th ANNIVERSARY

Poetess Gertrude Stein once said "a rose is a rose is a rose." Though no one ever quizzed this erudite femme on cities, the chances are she never would have said, "A city is a city," if she had ever visited Chicago.

When you alight from your plane or train, space-ship or pogo stick and you find yourself longing for excitement and opportunity you'll find it here, complete with its beauties and art treasures; but for one who wishes to think Chicago wicked—stop trying to feel virtuous and have a good time. Here is a city that provides wall to wall humanity with many striking innovations for real living, and all of it in an atmosphere that is conducive to comfort and conviviality.

No other metropolis is as "sports crazy" or fun loving. Whenever you arrive, there is almost certain to be some headline athletic event on schedule. Like one of Aristotle's "unaccountables," we proudly claim two major league ball clubs: the Cubs and the White Sox with matching ball parks: Wrigley Field and Comiskey Park.

Chicago is the capital of the midwest. To a Chicagoan, Chicago is the Capitol of the world. She is not dreary and dangerous as a visitor might think, but rather alive and exciting like tinsel on a tree on Christmas morning.

In the downtown theatrical district, Randolph Street is not downstaged by London's Soho. Rush Street, on the glittering near north side, with its hide-aways, garrets and apartments full of artists, writers and painters, French restaurants and night clubs, is a living portrait of the Montmartre in Paris. The night clubs and "hot" music spots seem to be going full blast all of the time. The only thing Chicago doesn't have is a ceiling. Chicago keeps you up all night and makes you long for a new day when life and humanity will again roam the streets and rush up and down her teeming avenues of exotic charm. While part of her city sleeps she awaits another day.

Another of Chicago's best known lures is the world renowned stores. From all over the world millions annually come for the sole purpose of shopping in the wondrous mercantile palaces of State Street, fittingly called by many

Rush Street at Night.

the real "Main Street of the Nation." Sharing this enticement are the scores of dazzling specialty shops stretching Southward along Michigan Boulevard from where it overlooks Lake Michigan and Grant Park, just east of the famed downtown Loop, to the even more imposing and more recently glorified "Magnificent Mile" that leads into the fabled Gold Coast District.

And just an encouraging note for those of you who went to Europe in 1959—The Palmer House has promised that there will be a bath in every room (with soap). However, for the hard rolls and coffee (called breakfast), you'll have to "rough it."

Chicago is excessive and calamitous having nearly reduced herself to bits in the Race Riots in 1919 and to ashes in 1871 when the gait of Mrs. O'Leary's legendary cow became unsteady. Chicago survived because, as it has been said, there are more real hard-core folks per square inch in Chicago than any other area in the world.

For the gourmet, the connoisseur of the fine arts, the jazz devotee, the egghead, the fun lover, the scientist, the curiosity seeker—where else could one hope to find satisfaction for all of these desires but in fabulous Chicago!

In the field of modern architecture, Chicago gave mankind its first steel-girder skyscraper. As Lord Chesterfield once said, "Most arts require long study and application, but the most useful art of all, that of pleasing, requires only the desire." So, in order to delineate these skyscrapers for the visitors' entertainment and to lend an exotic and enchanted air to the city, vantage points were eruditely placed atop these buildings—from the CAROUSEL-IN-THE-SKY, 44 floors atop the world's tallest hotel (the Morrison), one has a fifty-mile view through glass walls. Now, while slowly revolving on a lazy susan (Carousel), suddenly the buildings of the loop loom as bewitching silhouettes of gossamer, seemingly woven by magic hands, a handiwork rarely seen and borrowed from Angels' gowns—and one is sure a notable dynasty could reign regally here.

During the day from the TOP-OF-THE-ROCK (on top of the Prudential building) 601 feet in the sky, one may see surrounding states, industry, ships and shoreline of an inland sea. And at dusk one begins to feel star-touched as tiny sail boats like swooping blue butterflies with tiny lights at their throats flutter electrically about Lake Michigan. Then at night, the TIP-TOP-TAP (Allerton Hotel) lures visitors for cock-

tails in the sky right in the heart of Chicago's "Magnificent Mile." From here, street-lamps seem like thin, foot-long candles giving the city a fairy-tale appearance, like a three-dimensional wall-hanging. You begin to explore a world of tinsel and glitter—for it's fantasy time—a zenith of lights appears before you and you realize that this is a city beautiful enough for framing.

The magnificent mile.

Research Group to Meet

Members interested in research are invited to attend the meeting of the Research Group to be held on Monday, July 3, during Annual Conference in Chicago. Brief reports of current research projects may be reported by members so engaged. A one-page summary of the proposed report should be sent before April 15 to Mrs. Rheta Weidenbacker, Program Chairman, Research Group, 3901 Pine Street, Division of Physical Therapy, University of Pennsylvania, Philadelphia.

Original Papers for Conference

Members of the Association who have been working on special projects related to physical therapy procedures—research, clinical or laboratory; reviewing results achieved with a group of patients; adaptation or application of new methods of treatment; or any other subject which will advance the profession—should plan now to report their work in Chicago next July.

Two copies of manuscript, typed (double spaced), should be submitted to Dorothy E. Voss, Editor in Chief, *Physical Therapy Review*, by Apr. 1, 1961. The *Review* Editorial Board will select papers to be read by members and has the prerogative of publishing those papers selected. Members will be notified of the Board's decision not later than April 25.

After Is Always

What has been your reaction when after working with a patient for many months, you, by invitation, see this patient in his home, or, by chance, meet him in the street? Was it a shocking experience? Did the patient, who as a *patient* improved at the rate expected in terms of the physician's diagnosis and prognosis, suddenly impress you as being more handicapped than you had thought? Did you, perhaps for the first time, see him as a *person* and relate to him as a person rather than as a patient? Was one of your reactions the wish that somehow this patient might have received further treatment, or treatment in a situation where his needs could be met in a way more challenging to him?

After is always for many patients. After leaving the hospital, some patients are always handicapped persons rather than patients. Always may not be a very long time for the geriatric patient; always is far too long for the employable adult; and always is forever for a child.

With proper aftercare, after might not be always. A period of time in a nursing home where physical therapy services are available, or in a rehabilitation center, or in a school for the handicapped might make the difference between partial or complete recovery, dependence or independence, unemployment or employment.

The 38th Annual Conference Program will have "something for everyone." The scientific content will appeal to those who work with children, those who work with employable adults, and those who work with aged patients. Thus, "something for everyone" becomes something for all patients—for, by attending Conference, physical therapists return to their patients with a renewed energy, a broader concept, and are better prepared to alter the "always."

Education

Scholarships for Specialized Training in Cerebral Palsy

Under a scholarship program co-sponsored by Alpha Chi Omega and the National Society for Crippled Children and Adults, Inc., physical therapists and other professional workers may qualify for specialized training for work with children and adults having cerebral palsy. The purpose of the program is to make more trained specialists available for service to the cerebral palsied and to supplement and increase the skill and knowledge of those already working with these persons.

Candidates must be fully qualified in their respective professional fields. Training courses for which scholarships are granted must have primary emphasis on cerebral palsy. Generally, approved courses may vary in duration up to three months.

Deadlines for receipt of applications are April 1 (for training starting in June through December), and October 10 (for training starting in January through May). Details about the program and application blanks can be obtained from: Personnel Service, National Society for Crippled Children and Adults, Inc., 2023 W. Ogden Avenue, Chicago 12, Ill.

The National Foundation Health Scholarships

The National Foundation has announced that a total of 450 students of nursing, occupational therapy, physical therapy, medical social work, and medicine have received Health Scholarships in 1960. Of these, 95 awards were made to prospective physical therapists from 45 states and Puerto Rico. In addition to these, 69 of the 83 physical therapy students, appointed when the Health Scholarship Program was instituted in 1959, are continuing for their second year of study. Thus, there are 164 recipients of National Foundation Health Scholarships who are currently enrolled in approved curriculums in physical therapy.

SHORT TERM COURSES FOR GRADUATE PHYSICAL THERAPISTS

Title of Course	*Sponsor of Course*	*For Details Contact*	*Dates of Course*
Cerebral Palsy	The North Carolina Cerebral Palsy Hospital Durham, North Carolina	Lenox D. Baker, M.D. Medical Director No. Carolina C. P. Hosp. Durham, North Carolina	Courses arranged according to individual need—duration 3 months
Cerebral Palsy Technics of Treatment	Children's Rehabilitation Institute for Cerebral Palsy Reisterstown, Maryland	Christopher H. Wiemer Executive Director Children's Rehab. Inst. Reisterstown, Maryland	April 3—June 16, 1961 July 3—Sept. 15, 1961 Oct. 2—Dec. 15, 1961
Theory and Technic of Treatment and Care of Neuromuscular and Musculoskeletal Disorders	Georgia Warm Springs Foundation Warm Springs, Georgia	Robert L. Bennett, M.D. Director Ga. Warm Springs Found. Warm Springs, Georgia	Mar. 27, 1961— June 16 or Sept. 8, 1961 Sept. 25, 1961 Dec. 15, 1961 or Mar. 23, 1961
Technics of Neuromuscular Facilitation	California Rehabilitation Center Vallejo, California	Margaret Knott, Chief P.T. Calif. Rehab. Center Vallejo, Calif.	April 1 July 1 October 1
Graduate Physical Therapy Program	Rancho Los Amigos Hospital Downey, California	Chief Physical Therapist Rancho Los Amigos Hospital 7601 E. Imperial Highway Downey, California	2nd Monday in March to 1st Monday in Sept. 2nd Monday in Sept. to 1st Monday in March

Title of Course	Sponsor of Course	For Details Contact	Dates of Course
Advanced Physical Rehabilitation Methods for Physical/Occupational Therapists	New York University Medical Center—Institute of Physical Medicine and Rehabilitation (in cooperation with New York University School of Education)	Edith Buchwald Lawton, Director, Postgraduate Education for Paramedical Personnel, New York University Medical Center, Institute of Physical Medicine and Rehabilitation, 400 East 34 Street New York 16, N. Y.	Apr. 24—May 19, 1961
Neurophysiology in the Treatment of Neuromuscular Dysfunction (P. T. 511)	U. of So. California Physical Therapy Dept. University Park Los Angeles 7, Calif.	Margaret S. Rood U. of Southern California	June 12—30, 1961 Oct. 9—20, 1961
Neurophysiological Response Mechanisms in Therapy (P. T. 521) Prerequisite P. T. 511	U. of So. California Physical Therapy Dept. University Park Los Angeles 7, Calif.	Margaret S. Rood U. of Southern California	April 10—28, 1961
Anatomy for Therapists (P. T. 502a)	U. of So. California Physical Therapy Dept. University Park Los Angeles 7, Calif.	Roxie Morris U. of Southern California	July 31—Aug. 25, 1961
Upper-Extremity Prosthetics	Post-Graduate Medical School & College of Engineering, New York University; & U.S. Office of Vocational Rehabilitation	Prosthetics Education New York University Post-Graduate Medical School 550 First Avenue New York 16, New York	May 15—26, 1961
	Northwestern U. and U.S. Office of Vocational Rehabilitation	Director of Prosthetic Education Northwestern U. Med. School 401 E. Ohio Street Chicago 11, Illinois	June 5—9, 1961
Lower-Extremity Prosthetics	Northwestern U. and U.S. Office of Vocational Rehabilitation	Director of Prosthetic Education Northwestern U. Med. School 401 E. Ohio Street Chicago 11, Illinois	Mar. 27—31, 1961 May 22—26, 1961
	Post-Graduate Medical School & College of Engineering, New York University; & U.S. Office of Vocational Rehabilitation	Prosthetics Education New York University Post-Graduate Medical School 550 First Avenue New York 16, New York	March 13—24, 1961 April 10—21, 1961
Physical Medicine and Rehabilitation—Functional Bracing, Neck and Back, Geriatrics	U. of Colorado Medical Center, Office of Postgraduate Medical Education, 4200 E. Ninth Ave., Denver 20, Colorado	Jerome W. Gersten, M.D. Director, Dept. of Physical Medicine and Rehabilitation, U. of Colorado Denver 20, Colorado	May 31—June 3, 1961

Abstracts

Effect on Coronary Circulation of Cold Packs to Hemiplegic Shoulders

E. J. Lorenze, G. Carantonis, and A. J. DeRosa (Cornell Medical School, New York), ARCH. PHYS. MED., 41:394-399, September 1960

Forty-five individuals were observed for possible effects on coronary circulation of cold packs applied to the shoulder. This study was undertaken to determine whether myocardial ischemia, due to reflex coronary vasoconstriction, might be a potential complication to the use of cold packs for painful hemiplegic shoulders.

The effect on coronary circulation was measured by electrocardiograms and by evidence of the anginal syndrome. Changes were also recorded in blood pressure, cardiac rate, skin temperature at distal points, pain, spasticity, and passive range of motion. Cold packs were administered for five minutes or more by using toweling which had been soaked in ice and water of approximately 32 degrees F. The area was covered from the base of the neck to the elbow, and from the anterior to the posterior border of the deltoid muscle. A total of five packs was used with changes at two minute intervals.

The patients who were observed were categorized as follows: ten normal subjects; ten patients with known episodes of myocardial infarction without hemiplegia; ten patients with left hemiplegia but no history or evidence of coronary artery disease; and fifteen patients with left hemiplegia and history or evidence of coronary artery disease.

The observations which were reported included the following. The average skin temperature drop was 20 degrees F., and the average drop in intramuscular temperature was 3 degrees F. The lowest temperature level was usually reached after application of the second pack. No increase in blood pressure was greater than 10 mm. Hg systolic. A pulse rate increase greater than 10 per minute was rare. Six of the eight individuals whose shoulder syndromes were classed as moderate displayed the most striking gains in motion and relief from pain. Only one individual displayed significant electrocardiographic changes. This patient had known coronary artery disease, but did not show clinical evidence of anginal syndrome.

The authors conclude that the possibility of hemodynamic changes in the coronary arteries cannot be dismissed, although it would not be expected to frequently accompany the minor temperature changes inherent in the use of cold packs.

Maximal Work Production in Man

J. G. Fletcher (Environmental Physiology Group, Defense Research Medical Laboratories, Toronto, Canada), J. APPL. PHYSIOL., 15:764-768, September 1960

If a man must perform hard physical work at a rate which exhausts him, one of two things is likely to happen. Either he will learn to work in bouts with rest pauses in between, or he will reduce the working rate to a level which he can maintain. His aims will be to avoid unpleasant symptoms of fatigue and exhaustion. However, if the man is sufficiently well-motivated to attempt the same high rate of work on several occasions, a third possibility arises. He may become accustomed to working at a higher steady rate than he could at first tolerate and then learn to maintain it.

The author studied the ability of 12 well-motivated men to perform hard work. This consisted of stepping up and down a 22-inch bench 30 times every minute until exhausted. A metronome was used to keep a steady rhythm. The subjects ranged in age from 20 to 46 years. Their athletic habits ranged from non-athletic to athletes in training. Occupations of the subjects are listed in table form.

When first tested, the non-athletes were not able to step as long as the athletes. The inactive subjects were not able to step as long as active ones; or athletes out of training were not able to step as long as those in full training. All of the subjects found that their endurance increased by 100 per cent or more. In five of them the improvement exceeded 500 per cent.

The article concludes with a discussion of physical fitness and its improvements by training, training effects in normal men and women, and the measurements obtained by the endurance stepping test.

Treatment of Fractures and Dislocations, 1950-1960

Henry Banks and Thomas Quigley (Department of Surgery and Orthopedic Surgery, Harvard Medical School, and the Peter Bent Brigham Hospital, and the Harvard Health Services, Boston, Massachusetts), N. ENGLAND J. M., 263:444-452, September 1, 1960

Dislocations and Fracture Dislocations of the Hip. These injuries have been occurring more often in recent years. Posterior dislocations are more common than anterior or obturator position.

Dislocations with acetabular fractures are more complicated to treat. If the fragment is small and the reduction is stable, surgical intervention is not indicated, otherwise it may be necessary. Although early exercise is important in these injuries, traction, until the capsule is healed, is even more important. Weight bearing is deferred until the posterior fragment is healed and there is no evidence of a vascular necrosis.

The most difficult injury in this area is the dislocated hip with fracture of the femoral head. If the fragment is small, closed reduction may result in healing and good function. If the fragment is large, good early results have been reported by the use of primary cup arthroplasty.

The Femoral Neck. Reduction and internal fixation of femoral neck fractures have resulted in union in as high as 80 per cent of cases, as compared to 25 per cent union in cases treated by closed reduction and hip spica, as used a quarter of a century ago. This fracture is different from any other. It heals across the fracture site and not by bridging callus about the periphery. In addition, the femoral neck has a very fragile blood supply which may be damaged or destroyed by the injury.

The authors' program for fracture of the femoral neck includes early operation, closed reduction with good x-ray control and light anesthesia, internal fixation with Smith-Petersen nail, and careful postoperative care to prevent premature weight bearing.

At least 37 types of prostheses are now available, each with its own advocates. For seven years the authors have used the Moore prosthesis for irreducible fresh fractures and the late complications (non-union and aseptic necrosis) with good results.

Intertrochanteric Fractures of the Hip. Surgical intervention seems to be the treatment of choice for intertrochanteric fractures, with few exceptions. This is preferred to conservative non-operative treatment with traction because the mortality rate is reduced, nursing care is easier, and the hospital course is much shorter.

Fractures of the Shaft of the Femur. Before 1950 the treatment of choice for fractures of the shaft of the femur was by traction, usually skeletal. This is a safe and effective method, especially for comminuted fractures. However the length of time in the hospital, prolonged disability from residual joint dysfunction, and muscle atrophy are valid objections to this therapy.

Intramedullary fixation has been the great advance in the treatment of properly selected fractures of the femur. It is now the treatment of choice for closed non-comminuted fractures of the femur occurring from a point 5 centimeters (cm.) distal to the lesser trochanter to a point about 15 cm. proximal to the adductor tubercle.

Supracondylar fractures of the femur may often be treated successfully with carefully applied and designed traction. Decreased knee motion and function may result from any form of treatment.

The Patella. It has been realized that the largest sesamoid bone in the body does serve a useful purpose. It acts as a protective buffer for the knee and as a pulley to increase the mechanical advantage of the quadriceps on the lower leg. Complete removal of the fractured patella, once a popular treatment, is now reserved only for cases with extensive comminution. One group found recovery of strength of extension in 98 per cent of cases when a substantial fragment was retained, and in 70 per cent after total patellectomy.

Sequelae of Abduction of the Tibia on the Femur. The results of abduction of the tibia on the femur, as seen in football injuries, fall into almost standard patterns for three general age groups. In late adolescence the weak link is the distal femoral epiphysis.

After closure of the epiphysis until middle life, the medial and anterior cruciate ligaments stretch and rupture. Prompt surgical repair, now firmly established, is the treatment of choice for ligamentous injuries.

After middle life, when the bone is less elastic, ligaments rarely give away, and the lateral femoral condyle, acting as a hammer, produces various patterns of crush and depression of the lateral tibial plateau. Elevation of the plateau, support by bone graft, and fixation by a bolt after removal of the lateral meniscus, is the usual technic employed. Early active motion is important.

Effects of Flexion—Extension Movements of the Head and Spine Upon the Spinal Cord and Nerve Roots

J. D. Reid, J. NEUR., LOND., 23:214-221, August 1960

In a series of dissections, the up-and-down movements of the spinal cord and dura were examined in flexion-extension movements of the head and spine. They were found to be of greatest extent (up to 1.8 centimeters) in range at the levels of roots C8 to T5. In flexion, the length of the spinal canal was increased and there was stretching of the cord and dura, chiefly between levels of roots C2 to T1, up to a maximum of 17.6 per cent. An attempt was made to measure the anterior component of force exerted by the cord and dura under various degrees of tension. This was found to reach maximum values of 30 to 40 pounds per square inch for a displacement of three millimeters.

From a pathologic point of view, it would seem probable that important effects might be produced in the cord by its movement, stretch, and compression, over and against the anterior wall of the spinal canal and its projections. Harmful effects of movement have been previously postulated and are likely to be greatest where the cord is stretched over a convexity, thus exerting pressure anteriorly.

Greatest flexion and greatest increase in length of the spine occur in the cervical region; but the stretch thus produced in the cord involves not only cervical but also thoracic segments. However, should thoracic stretch be prevented (or modified by fixation of dura to disc protrusions) then the full effect of flexion must be borne by such length of cord as is isolated above the area with adhesions. It has been claimed that one of the chief objects of surgical removal of bony spurs in cervical spondylosis is to restore soft tissue glide and that relief of symptoms is proportional to the movements regained.

It is stated that information on the degree of spinal curvature and changes in flexion at different levels and for different ages is not available, apart from the fact that the maximum depth of the normal thoracic kyphos is at the sixth thoracic vertebra. Further measurements are required.

From the author's few observations, it would seem that in normal posture and over a three-millimeter projection into the canal, an anterior pressure of about 2 pounds to the square inch is exerted by the cord and dura. In flexion, pressures of 30 to 40 pounds per square inch may be obtained. Degenerative shortening of the spine or any factors tending to slacken the dura would reduce the pressures possible against osteophytes; and this may account for the fact that symptoms of spondylosis present chiefly in middle aged groups rather than increase steadily with age. No evidence has been found to incriminate the roots as means whereby the cord is held forward. Rather, it is suggested that in flexion of the head and neck, movements and stretch of cord and nerve roots, and the development of anterior components of force over a convex spine are likely to be the more important factors in causing myelopathy and radiculitis.

Not only may movements and pressure inflict direct trauma on the cord, but by interference with its blood supply they may conceivably cause indirect damage. Intermittent spasm, mechanical occlusion, or thrombosis of the anterior spinal artery might well occur. Such mechanisms have been implicated, particularly in cervical spondylosis. Flattening and blanching of the cord in cervical flexion and obliteration of venous channels over spondylitic spurs have been noted. The effects of lateral and up-and-down movements of roots over or against pedicles, osteophytic or disc protrusions might well result in root sleeve fibrosis. Should the major cervical contribution to the anterior spinal artery be involved, serious cord damage could be envisaged.

Among factors reported to predispose to root and cord damage in cervical spondylosis have been narrowing of the canal in extension or infolding of the ligmenta flava, as well as congenital or spondylitic narrowing. None of these can be questioned as real factors; although their

general importance may be difficult to evaluate.

Numerous photographs depicting the posture of the neck or the spine and its effect on the cord, nerve roots, and vertebral bodies are included in the article.

A Study of the Afferent Discharge Produced by Cooling a Mammalian Muscle Spindle

O. C. J. Lippold, J. G. Nicholls, and J. W. T. Redfearn (Department of Physiology, University College, London). J. PHYSIOL., LOND., 153:218-231, September 1960

Muscle spindles in the mammal fire spontaneously, in the absence of stretch, when they are brought to temperatures below 32° C. (degrees centigrade). In studying the characteristics of response to cold in single afferent fibers from muscle spindles, it was found that when a muscle was cooled slowly the discharge began at 32° C. The frequency of discharge was approximately 10 sec. (per second), gradually rose to a maximum of 15/sec. at 28° C., and then declined. It fell to zero at about 15° C. Rapid changes of temperature caused higher rates of firing, but the final rate depended on the final temperature and not on the rapidity with which it was reached.

It was found that not all muscle spindles in the isolated tenuissimus of the cat became active when cooled. Usually a third of the muscle afferent fibers remained inactive unless stretched. Those fibers remaining inactive to cooling gave the largest action potentials when stretched. Since spike height is directly proportional to conduction velocity, and conduction velocity is proportional to fiber diameter, it follows that there is a cold response only in sensory endings connected to the afferent fibers of small diameter. However, in high potassium or low calcium concentrations the larger fibers developed a response to cold.

Factors which caused depolarization of the nerve ending (potassium concentration, stretch, direct current polarization) accelerated the afferent discharge at temperatures below 32° C. Hyperpolarization (direct curent polarization, or low potassium concentration) reduced or abolished this activity.

Threshold to stretch was reduced at the lower temperatures. A stretch at 37° C., which would evoke a high-frequency burst of impulses would produce at 20° C. a just detectable increase in frequency of the firing due to the cold discharge.

Sports Medicine

J. D. G. Troup, LANCET, LOND., 2: 699-700, September 24, 1960

Sports research is being done in medical centers in Finland, Sweden, Russia, and West Berlin. Investigations are made into the physiology, the psychology, and the statistics of sports medicine. Although the United Kingdom may not lag behind in sport for lack of specialists in sports medicine, it is certain that a very useful contribution toward training methods could be made if there were more physicians interested in this field. What can be learned from sports has a tremendous bearing on some of the illnesses which come under the vague heading of rheumatism.

Sports injuries and training methods are important to the study of medicine because the minor injuries and strains to which the athlete is subject are closely related to conditions classified as rheumatism, fibrositis, lumbago, "neuritis," and so on. These conditions take up more of the medical profession's time than practically any other single group of diseases, and they have one thing in common—they represent deviations from the normal mechanical efficiency of the body.

The symptoms of the athlete can be cured if he gives up athletics; but the same thing in the tired, middle-aged housewife has to be palliated and endured. Osteoarthritis, though essentially a degenerative process, must be preceded by loss of function, local circulatory failure, or neurodystrophic processes, or by a combination of all three. If the history of a patient with osteoarthritis is taken carefully, one often finds that the process began with a minor sprain, or an attack of lumbago—the sort of lesion which can be the result of some minor injury or repeated strain in which the healing was incomplete. If the person does not exert himself, following a mild strain or sprain, he may remain symptom-free. Many people never do exert themselves, but often unconsciously adopt some postural deviation, which relieves the strain from the unhealed lesion, but which imposes a mild chronic strain elsewhere. One-sided muscle weakness is bound to follow loss of function and the adoption of a postural fault.

Just as an athlete must train intensively to achieve peak performance, so must the patient deal with a disability, if he wishes to overcome his disability and live a normal life. Even when osteoarthritis is advanced, it is worth trying to relieve the loss of function which sets off the osteoarthritic processes. An arthritic can gain remarkable relief if he "goes into training."

There is a mass of information on increasing strength, bulk and endurance of muscles, but what we need is knowledge concerning the strength of muscles and muscle groups which act on a joint. We need to know the relation of the muscles to injury of the joint, and to all the interrelated factors affecting joints under stress. If "sports medicine" can answer these questions, we shall learn a great deal about treating sports injuries, about athletic training methods, physical education, the prevention of joint degeneration, and about the treatment of common skeletal aches and pains.

The sooner we learn the extent to which our well-being depends on the mechanical and functional efficiency of the body, the better. "Sports medicine" may well provide the answers.

Abstracters for February

We are indebted to the following Association members for the carefully prepared abstracts that appear in this issue:

Rachel Adams
Elizabeth Davies
Nanette Keegan
Geraldine Midgley

Book Reviews . . .

The Human Spine in Health and Disease. (1st American Edition.) By George Schmorl, M.D., and Herbert Junghanns, M.D. Translated and edited by Stefan P. Wilk, M.D., and Lowell S. Goin, M.D. Cloth, illus. 285 pp. New York: Grune & Stratton, 1960. $21.00.

This monograph was first published in 1932 and soon became the authoritative reference in its field, in so far as European pathologists and orthopedists were concerned. The present translation, from German, is based upon the 1957 edition. As is true of most translated works, there is some unfamiliar terminology. Dr. Schmorl was responsible for the anatomico-pathologic descriptions; Dr. Junghanns supplied the radiographic interpretations. These men were leaders in their respective fields. The text is very concise with no digressions or wasted words. The format, type, and illustrations are excellent.

The specimens upon which the findings are based came from post mortem examinations of more than 10,000 spines studied over a five-year period. There was dissection and radiographic or photographic study in all cases, and serial sectioning as indicated.

This book assumes that the reader has mastered elementary embryology, anatomy and pathology and is now ready for advanced study. There are nine major divisions, starting with development and structure of the normal vertebral column, followed by congenitial anomalies, osseous pathologies, disc pathologies, and, finally, clinical pictures involving large areas or the entire spine. Curiously, very little is said on the subject of scoliosis, which was given as a major reason for the existence of this exhaustive study. As is true for many monographs, the authors spend more time on conditions which are rarely seen than on those with a high frequency of occurrence. Treatment of described lesions is not touched upon.

The bibliography is exceptionally extensive, even for a monograph of this size and scope. Unfortunately, most of the reference material is not in English, and hence will be inadequately available to the American reader.

This monograph will be of little or no help to the clinical physical therapist. It probably is an excellent reference for pathologists and orthopedists, and for the individual pursuing knowledge for the sake of knowledge.

Psychological Appraisal of Children with Cerebral Defects. By Edith Meyer Taylor, Psychologist, Cerebral Palsy Unit, Harvard Medical School. Cloth, illus., 499 pp. Cambridge, Mass.: Harvard University Press, 1959. $8.50.

This book has been written primarily for clinical psychologists who are concerned with differential diagnoses of the psychologic aberrations and problems of children suffering from cerebral injuries. It will be of general interest to physicians, nurses, therapists, teachers, social workers, and all who work professionally with children who have cerebral defects.

The volume has a thirty-seven page introduction which describes minutely the history and background for the work presented in the following chapters. Dr. Taylor tells of her experiences in the close association of Dr. Bronson Crothers in the Neurological Division of the Children's Medical Center in Boston. There is discussion of the rationale for the testing and appraisal technics that were used, as compared to methods used by other workers. Several valuable tables are presented in the introduction which provide data from the recently published study of Crothers and Paine, concerning the intellectual competence of cerebral palsied patients, according to a medical classification grouping, as well as a comparison of early and later estimates of intellectual competence.

In Part I Dr. Taylor has presented in detail the progress notes recorded from the appraisal of seven children affected by injuries of various cerebral etiologies. These are quite uniquely called "case portraits." The accounts provide evidences of the child's intellectual, sensory-motor, emotional, and personal-social development from birth to twelve years. The cases cited are from two main categories: 1. Defects dating from birth (or before) which includes a spastic hemiplegia; two extrapyramidal lesions: athetoids with dysarthria, and one hydrocephalus spastic paraplegia. 2. Defects dating from later injury which includes one child who had pneumococcus meningitis at the age of six months; one who had encephalitis at five years; and one who had a head injury at seven years. There is much of interest here, but the reader should have some basic knowledge of the normal developmental sequences. Of particular value is the constant reference to parental attitudes and behavior which is correlated with the child's behavior.

Part II contains two-hundred pages devoted to a description of the specific evaluation technics used in the case studies. Variations and alternatives are suggested. References are numerous. Some interesting and revelant technics are included, even though they are not represented in the case studies. Diagrams and procedure are offered for such categories as testing with blocks, pictures, paper and pencil, fitting and assembling objects, and evaluation principles for verbal and nonverbal learning, memory, judgment, reasoning, and common sense, as well as academic tools.

Physical therapists who treat cerebral palsied children should have insight into the methods used here since staff conferences constantly refer to such evaluations. More understanding of the child in the psychologic areas will lead to much better planning of the exercise program and a more realistic approach to the child and his parents.

Care of the Patient with a Stroke. By Genevieve Waples Smith, R.N., M.A. Paper; illus.; 148 pp. New York: Springer Publishing Co., Inc., 1959. $2.75.

This treatise on the care of a patient with a stroke essentially portrays one individual's experience with a family member. It may be helpful to a number of patients' families in the event of a similar situation—when an individual suffers any one of the number of cerebral accidents which result in a "so-called stroke."

The author has considered the multiple areas needed to be covered in the care, treatment, and understanding of the patient who is left with a residual disability. Suggestions for practical nursing and therapy, including message and exercise,

are helpful and purposeful for each type of cerebral vascular accident. Nurses unfamiliar with the total details of such a rehabilitation program, and therapists needing to acquaint themselves with the home program for a patient, will find these suggestions most helpful.

The emotional aspects of a stroke have been treated with some generalities which are not always common. In the interdisciplinary approach to treatment and rehabilitation for the patient with a residual disability, it is generally understood that the patients' basic personality structure influences his acceptance of his disability, his limitations, his motivation, and, to a great extent, his ultimate rehabilitation potential. However, the author has vividly portrayed one family's emotional situation in the facing of reality and acceptance of the member who not only has a limited ability but may often lack communication with his loved ones. The frustrations of both, and the continuous seeking for understanding and communication, are sensitively expressed.

Most authorities would disagree with the statement that training should be emphasized with the good hand after all else has failed. In general, immediate efforts are started to educate the unaffected hand to function since it is questionable that the affected hand will be able to perform with its usual ability.

An important consideration in rehabilitation, and not mentioned, is the physical health of the patient. Under medical direction, programs may need to be modified, depending upon the patient's health status. Cardiac and hypertensive complications often deter a patient's progress. It is also helpful for the family, nurse, and therapist to know the degree of mental impairment of the patient, following a cerebral vascular accident, so that a program within the limits of a patient's ability is instituted. Considerable frustration, disturbed relationships, and also serious accidents may occur when more is expected of the patient than he is mentally able to accomplish.

It would have been more helpful to families reading this book if the author had included a chapter on the community resources which are available to help such a patient. Unless very thorough and adequate instruction is given to the family in the entire program, including nursing as well as therapy, families might be quite confused in carrying out the details outlined in this book. The community resources known to be of valuable assistance are the public health nurse, physical therapist, occupational therapist, and volunteer groups, all of whom might play a very important part in helping the family in their total rehabilitation and return to happy and purposeful living.

The reviews published here do not necessarily represent the opinions of the American Physical Therapy Association.

Book Reviewers for February

Eleanor M. Anderson, Assistant Professor, Public Health Nursing, University of Minnesota, Minneapolis, Minnesota.

James E. Griffin, Ph.D., University of Pennsylvania, Division of Physical Therapy, Philadelphia, Pa.

Rheta A. Weidenbacker, Associate in Physiology, University of Pennsylvania, Philadelphia, Pa.

Booklets Received

Films for Nursing Education

Pennsylvania State University, Audio-Visual Library, University Park, Pennsylvania, 1960.

A listing of films available from this library with a commentary on each.

Financing and Operating Rehabilitation Centers and Facilities

By Basil J. F. Mott, National Society for Crippled Children and Adults, Inc., 2023 W. Ogden Ave., Chicago 12, Ill.

A study of ten centers is presented in this third report of a series concerned with the operation of rehabilitation centers.

Nurses Can Give and Teach Rehabilitation

By Mildred J. Allgire, R.N., R.P.T., M.A., and Ruth R. Denny, R.N., R.P.T., B.S. Springer Publishing Company, Inc., 44 East 23rd St., New York 10, N. Y., Nov. 1960. Price $1.25.

An elementary manual of rehabilitation technics for nurses.

Prostheses, Braces and Technical Aids

Volume 7—Spring; and Volume 8—Summer, 1960. Published by the International Society for the Welfare of Cripples, Committee on Prostheses, Braces and Technical Aids, 34 Esplanaden, Copenhagen K, Denmark.

These journals present in English articles from various areas of the world on braces and prostheses.

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New items which may be of interest to physical therapists will be mentioned in these pages each month. The accompanying explanations are made by the manufacturers and have not been investigated by the *Physical Therapy Review*.

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Positions Available

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IMMEDIATE OPENING: Permanent position for staff physical therapist registered with ARPT and/or APTA. Medium sized department with excellent facilities in progressive children's hospital with student affiliation program. Suburban community near Hartford; 5-day 40-hour week; liberal benefits, including pension program, hospital insurance, paid vacation, holidays, and sick time. Salary based on experience. Complete maintenance available, if desired. Contact Personnel Department, Newington Hospital for Crippled Children, 181 East Cedar Street, Newington 11, Conn.

MIDDLE ATLANTIC

STAFF THERAPISTS—N.Y.U. Medical Center affiliated hospital. Diversified experience offered: General Physical Therapy, Rehabilitation, and Respirator Sections. $4680-5580 with annual increments. Liberal vacation, sick leave policy. Write Department PM&R, Goldwater Memorial Hospital, Welfare Island, New York 17, N. Y.

APPLICATIONS CONTINUALLY ACCEPTED for staff therapists in rehabilitation hospital treating children and adults. Addition completed recently includes complete new P.T. department. Current staff of seven is being gradually increased to meet greater in- and out-patient capacity. Progressive personnel policies. Salary commensurate with experience and training. Location ideal for cultural interests and all sports. Further information and attractive brochure furnished on request. Apply to Administrator, Sunnyview Orthopaedic and Rehabilitation Center, Inc., 124 Rosa Road, Schenectady 8, N. Y.

STAFF PHYSICAL THERAPIST in a general hospital accessible by train, subway, bus, or car. Please contact Sister M. Patricia Ann, O.P., at Mary Immaculate Hospital, 152-11 89th Ave., Jamaica, N. Y., or call AX 1-3300.

PHYSICAL THERAPIST for a Visiting Nurse Association carrying on comprehensive services to the sick in their homes on a visit basis. Stimulating community program expanding its services to the chronically ill. Retirement plan, Social Security, forty-hour week, one month's vacation. Starting salary based on experience; annual salary increments. Apply: Executive Director, Visiting Nurse Association of Allegheny County, 200 Ross Street, Pittsburgh 19, Pa.

STAFF PHYSICAL THERAPIST for well equipped department in 260-bed general hospital. Starting salary $4,200. Vacation, sick leave benefits, lunch provided. Apply Personnel, Lebanon Hospital, 1650 Grand Concourse, New York 57, N. Y.

PHYSICAL THERAPIST: New York Polyclinic Medical School and Hospital expanding physical medicine and rehabilitation dept. General rehab. problems. Good salary with increments, sick leave, paid vacations. Apply: Personnel Office, 345 W. 50 St., N.Y. 19, N.Y. CO 5-8000.

STAFF THERAPISTS for 523-bed general hospital in Manhattan. Excellent salary range and benefits. Applicants must be eligible for licensure in N.Y. State. Write: E. J. Megerian, Asst. Dir. Personnel, St. Luke's Hospital, 421 W. 114 St., New York, N.Y.

STAFF PHYSICAL THERAPISTS (2) for 100-bed children's rehabilitation center. Excellent possibilities for professional growth; graduate education available. Fine working conditions and liberal benefits. Salary dependent upon experience. Inquire: Chief Physical Therapist, Home For Crippled Children, 1426 Denniston Ave., Pittsburgh 17, Pa.

PHYSICAL THERAPIST—571-bed general hopsital in suburban area; newly equipped department has 4 registered therapists and 3 aides. In- and outpatients for Orthopedic, Neurology, Internal Medicine, Neurosurgery, and rehabilitation work. Salary open, range with increments; excellent fringe benefits. Write: The Reading Hospital, Personnel Dept., West Reading, Pa.

PHYSICAL THERAPIST for crippled children's home at seashore. 5-day 35-hour week. 3 weeks paid vacation, 10 days sick leave. Salary open. 6 mo. increments. Full maint. available. Apply Mrs. Leone Drum, Supt., Betty Bacharach Home, Longport, N. J.

WANTED: Qualified physical therapist for cerebral palsied patients. Hours 9:00 A.M. to 3:30 P.M., 5-day week, 2 months (July and August) paid vacation. Salary commensurate with experience. Write to United Cerebral Palsy Society of Hudson County, 2078 Boulevard, Jersey City, N. J., or telephone HEnderson 5-0933.

HELP WANTED: MALE OR FEMALE. Physical therapist (RPT) for new 218-bed general hospital. Salary open. Liberal personnel policies. Small town close to Pocono mountain resorts, New York City and Philadelphia. Apply to: W. T. Payne, Jr., Warren Hospital, 185 Roseberry St., Phillipsburg, N.J.

THE HOSPITAL FOR SPECIAL SURGERY, New York City, has an opening for a STAFF THERAPIST. 194-bed orthopaedic hospital, inpatients and outpatients. Large teaching center. New bldg. Air-cond. apt. available. 5-day week, 4 weeks vacation, 10 paid holidays, liberal benefits. Write: 535 East 70 St., New York 21, N. Y.

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Positions Available

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SOUTH ATLANTIC

WANTED IMMEDIATELY: Two (2) Staff Physical Therapists, expanding department of an orthopaedic clinic. Department under direction of a physiatrist. Vacation, sick leave, holidays. Inquire: Arthur E. White, M.D., Anderson Clinic, South 25th Street & Army-Navy Drive, Arlington, Va.

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STAFF THERAPIST—Treatment Center for children with orthopedic and neurological conditions; balanced variety of conditions. In- and outpatient service. Recently enlarged and improved P.T. Dept. Good starting salary with merit increases, 5-day week, annual two-week vacation, 6 paid holidays, sick leave, excellent retirement plan. Liberal personnel policies. Living quarters available. Contact W. H. Bird, Adm., Asheville Orthopedic Hospital, Asheville, N.C.

REGISTERED PHYSICAL THERAPIST—for Therapy Department of 225-bed general short-term hospital. Present expansion program now in progress for 40 additional beds and various other increased facilities. 40-hour week, excellent salary and vacation, six paid holidays. Write: Administrator, Wheeling Hospital, Wheeling, West Va.

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PHYSICAL THERAPISTS WANTED for expanding private Orthopedic Clinic of six Orthopedic Surgeons in the rapidly growing city of Charlotte. New spacious air-conditioned building, paid vacations, group health insurance participation and professional liability insurance furnished. Salary dependent on experience (experience not necessary). Apply: Mr. Lewis W. Sykes, Business Mgr., The Miller Clinic, 1822 Brunswick Ave., Charlotte, N.C., or Miss Maria M. Kennedy, Chief Physical Therapist.

Positions Available

S. ATLANTIC (con't)

STAFF THERAPIST (Female) for a 225-bed Children's Hospital. Write details of education, experience and references to: Personnel Director, Children's Hospital of D.C., 2125 13th St. N.W., Wash. 9, D.C.

EAST NORTH CENTRAL

MALE OR FEMALE registered physical therapist wanted immediately to head department established two years ago in this 170-bed general hospital located in an expanding summer and winter resort area. Salary range $4,800 to $6,240. Apply Administrator, War Memorial Hospital, Sault Ste. Marie, Mich.

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STAFF PHYSICAL THERAPIST (female) to work in midwestern 350-bed hospital. In- and outpatient work, 40-hour week. Paid Blue Cross hospitalization, good life insurance and retirement plans. Write Chief Physical Therapist, Trumbull Memorial Hospital, Warren, Ohio.

STAFF PHYSICAL THERAPIST: Position available. Salary range $4525-$4975. Starting salary based on experience. Merit increases. 37½-hour week, vacations, holidays, sick leave. Well-equipped department. Affiliated with Northwestern University Medical School. P.T. student training program. Comprehensive rehabilitation program for in-patients and out-patients. 70-bed hospital. Congenial atmosphere. Excellent opportunity for personal development. Should be graduate of approved school of P.T. and hold membership in APTA or Registry. Contact Miss Hildegard Myers, RPT, Rehabilitation Institute of Chicago, 401 E. Ohio St., Chicago 11, Ill.

REGISTERED PHYSICAL THERAPIST for well-equipped department in 425-bed general hospital, located in pleasant, residential, lake-shore suburb of Chicago. Good salary, 40-hour week, progressive personnel policies. Apply: Personnel Office, Evanston Hospital, 2650 Ridge Avenue, Evanston, Ill.

IMMEDIATE OPENING for a registered physical therapist to work in hospital's well-equipped physical therapy department. Of special interest: variety of cases and closely knit team approach with medical staff, liberal personnel policies, salary commensurate with experience. Contact Glenn C. Williams, Administrator, Mary Free Bed Guild Children's Hospital & Orthopedic Center, 920 Cherry Street, S.E., Grand Rapids 6, Mich.

PHYSICAL THERAPIST for general hospital work. Completely new facilities, four therapists, University affiliation. Complete program of benefits including three weeks vacation to start. New 100-bed rehabilitation-oriented facility being developed for chronically ill. Write: Mark Slen, Assistant Administrator, Parkview Memorial Hospital, Fort Wayne, Ind.

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Positions Available

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WANTED

Registered experienced physical therapist for rehabilitation service with the Visiting Nurse Service of Madison, Wisconsin—April 15th. Consultation and teaching of nursing staff as well as direct treatment of a variety of cases carried under medical prescription. Five-day, forty-hour week, one month vacation, sick leave, holidays. Salary dependent on qualifications. Car necessary, generous reimbursement. Community offers educational and cultural opportunities. Apply: Miss Ruth E. TeLinde, Director, Visiting Nurse Service, 2059 Atwood Ave., Madison 4, Wis.

EAST SOUTH CENTRAL

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WEST NORTH CENTRAL

PHYSICAL THERAPIST WANTED, salary dependent upon experience and training; forty-hour week; sick leave; holidays; vacations; retirement plan. Pleasant working conditions in new air-conditioned department of a progressive 375-bed general hospital. Complete cross section of medical, surgical, and interesting orthopedic cases. Approved by State Crippled Children Department, Vocational Rehabilitation Service, and Workmen's Compensation Commission. Contact Administrator, Methodist Hospital and Medical Center, St. Joseph, Mo.

MINNEAPOLIS, MINN.: Opening for Physical Therapist in our modern Rehab. Center. Excellent working conditions. 400-bed general hospital. Salary $4800. Write to Coordinator of Rehabilitation, Fairview Hospital, 2312 So. 6th St.

PHYSICAL THERAPIST $4656.00 to $5592.00 per year. Salary at which appointed will depend on qualifications. Must be professionally qualified. Employee benefits include 3 weeks paid vacation, 11 paid holidays, paid sick leave, paid medical surgical and life insurance and others. 800-bed metropolitan hospital. Apply: Ramsey County Civil Service Deprtment, 1845 Court House, St. Paul 2, Minn.

WANTED: PHYSICAL THERAPIST for children up to 21 years—multiple disabilities. Renowned orthopedic staff; clinical affiliation with U. of Minn. Good salary; merit increases; 11 paid holidays; excellent retirement plan. Close proximity to summer and winter sports area. Write: Lucille Brauns, Supervisor of Physical Therapy, Gillette State Hospital for Crippled Children, 1003 E. Ivy, St. Paul 6, Minn.

PHYSICAL THERAPIST, 52-bed general hospital approximately 4,000 procedures in 1960; 60% outpatient; 40% inpatient. Starting salary for recent graduate $375 ($425 to $450 with experience); 2 weeks paid vacation, Blue Cross paid by the hospital; sick leave accumulative to 30 days. Opportunity to help plan new dept. in County Hospital. Contact L. D. Feeback, Adm., Warrensburg Medical Center, Warrensburg, Mo. Telephone 1193.

ONE CHIEF PHYSICAL THERAPIST, ONE STAFF PHYSICAL THERAPIST for a 210-bed general hospital, located in town of 70,000. Active orthopedic outpatient service. Salary commensurate with experience and education, upwards of $4800 per year. Periodic merit increases and other fringe benefits. Write or call Personnel Director, Sioux Valley Hospital, 19th and Euclid, Sioux Falls, S. D.

WEST SOUTH CENTRAL

OPENING FOR EXPERIENCED registered physical therapist (female) Sept. 15th in private Orthopedic Clinic. Salary $400 per month plus yearly bonus. 35-hr. week. Two weeks paid vacation. Contact Graybill-Wilson Orthopedic Clinic, 1202 Arlington, Lawton, Okla.

IMMEDIATE STAFF OPENINGS for 2 Male Registered Physical Therapists. Starting salary $450 monthly. 5-day week. 100-bed special hospital for arthritis. For further information write: E. K. Clardy, M.D., Leo N. Levi Memorial Hospital, P.O. Box 850, Hot Springs, Ark.

URGENTLY NEED qualified physical therapists for inpatient and outpatient services. Under university auspices. La. Chapter, Arthritis & Rheumatism Foundation. 1430 Tulane Ave., New Orleans 12, La.

STAFF PHYSICAL THERAPIST wanted for modern well-equipped Physical Therapy Department in private office. Patients both industrial and private. Excellent salary, periodic increments, paid vacation, Blue Cross and other liberal benefits. Apply to Drs. Houston, Roy, Faust, and Ewin; attn: Lola E. Smith, Chief Physical Therapist, 914 Union St., New Orleans 12, La.

Positions Available

MOUNTAIN

REGISTERED PHYSICAL THERAPIST (woman) for out-patient New Mexico Rehabilitation Center Inc. Immediate opening; 5-day week, paid vacation and sick leave. Social Security. Salary in keeping with experience. For details write to Arthur Osterholm, 1023 Stanford Drive NE, Albuquerque, New Mexico.

RPT: STAFF OPENING, well-equipped, air-conditioned department. Excellent policies and benefits. Idaho Elk's Rehabilitation Center, Boise, Idaho.

REGISTERED STAFF PHYSICAL THERAPIST (female). 200-bed general JCAH hospital. No experience necessary. 40-hr. week, excellent salary, liberal fringe benefits. Paid vacation and sick leave, 7 paid holidays. Attractive nurses' home available. Contact Administrative Assistant, Memorial Hospital, Cheyenne, Wyo.

PACIFIC

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CRIPPLED CHILDREN'S SERVICES

Graduates—Approved schools for Physical Therapy. Positions open in special schools for handicapped children. Starting salary $507; liberal employee benefits. Temporary appointment pending California registration. Write Dept. Civil Service and Personnel, Rm. 403, Civic Center, San Diego, Calif.

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GRADUATES OF APPROVED SCHOOLS FOR PHYSICAL THERAPISTS: You may now practice under professional supervision in this State pending registration with the California Board of Medical Examiners. Positions open in State Hospitals, the Veterans Home, and special schools for handicapped children. Starting salary $458, higher in some locations; liberal employee benefits; promotional opportunities. Streamlined civil service examinations twice a month in San Francisco and Los Angeles, and on request in other states near candidate's residence. Write: State Personnel Board, 801 Capitol Avenue, PT 71, Sacramento 14, Calif.

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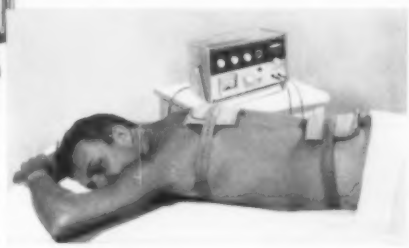

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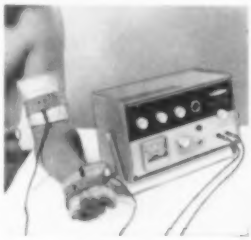

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